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INSTITUTE OF GAS TECHNOLOGY

THE GAS INDUSTRY'S OWN EDUCATIONAL AND RESEARCH FACILITY

CHICAGO 16, ILLINOIS

GAS ABSTRACTS

MARCH, 1959

VOLUME 15 NUMBER 3

AFFILIATED WITH

ILLINOIS INSTITUTE OF TECHNOLOGY

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O. P. BRYSCH, Editor — P. J. CHATTA, Assistant Editor

GAS ABSTRACTS is published and distributed monthly by the Institute of Gas Technology, Chicago 16, Illinois. The contents of selected papers and patents are reviewed impartially by the editorial staff and material of potential interest to the Gas Industry is presented. Subscription rates to non-members of the Institute: $18.00 per year to U.S. addresses; $22.00 foreign—Printed in the U.S.A.

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1. MANAGEMENT

Gas Industry Expansion

Larger Gain in Natural Gas Production in 1959 Seen. *World Oil 148,* 103 (1959) Feb. 15 (4 pp.)

U.S. marketed production of natural gas will increase to a new peak of 11.5 trillion CF in 1959, about 4.4% more than the volume marketed in 1958. Marketed production in 1958 amounted to about 11,015 billion CF, according to estimates. This was only 3.1% more than in 1957. Predictions for stepped up growth of natural gas consumption and production in 1959 is based on demand for gas stimulated by better business in general and increased industrial production, and fact that supply of natural gas available for consumption will be increased through accelerated expansion of pipeline facilities, following recent allevation of governmental controls over the industry.

Supply-Demand Outlook Is Improving. *World Oil 148,* 87 (1959) Feb. 15 (4 pp.)

Domestic production of crude oil and natural gas liquids will experience a markedly improved market during 1959. Reasons: Prediction of 4.3% increase in demand for all oils, resulting from an expected upturn in U.S. business activity; excellent possibility that product curbs will be included in the new import program expected early in March; progress in liquidating surplus crude and product inventories during 1958.

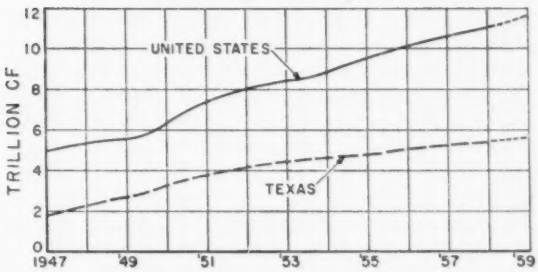
California: Growing Market for Gas. *Oil Gas J. 57,* 68 (1959) Mar. 2 (2 pp.)

Until now, El Paso Natural has been the sole supplier from outside California—and has been pushed to supply enough gas. Company's excellent service to booming California is principal reason that it has grown from a small local and regional supplier into the nation's largest gas transmission company. Enviable position appears to be at an end. Competition includes Transwestern Pipeline Co. and Tennessee Gas Transmission Co.

Producing Gas Wells Record Continuing Gain During 1958. *World Oil 148,* 148 (1959) Feb. 15.

Number of gas and gas condensate producing wells in operation at the end of 1958 was 15,105 greater than five years ago, but only 19,116 wells more than 10 years ago. Rate of growth during 1958 was larger than in 1957, despite the decrease in total U.S. drill-in activity which amounts to about 9%. Wells producing at year end in 1957: 78,869; in 1958: 83,328.

U.S. Marketed National Gas Production Continues Steady and Rapid Growth



(Adapted from *Larger Gain in Natural Gas . . .*)

Gas Really Has a Hard Sell. J. H. Collins. *Public Util. Fortnightly 63,* 379 (1959) Mar. 12 (11 pp.)

Today gas industry is being told that: it has been riding high on pipelines' boom; natural gas has brought it millions of new customers; coal and oil furnaces have been converted for house heating; manufactured gas has been supplanted everywhere. Competition for cooking, water-heating and house heating is keen. But old point-of-sale competition is not enough; formidable project of appliance research to increase its usefulness in U.S. economy is necessary. Also, to prepare for day when synthetic fuel will be its commodity. As for the point-of-sale rivalry, both services will grow on it as in the past.

Fifty Years in the Gas Industry. A. Marsden. *Gas J. 297,* 231 (1959) Feb. 11 (11 pp.)

Very broad review of evolution of gas industry as seen through the eyes of a man who spent fifty years as a member.

Methane Liquefaction

Huge Growth Seen for Liquid Methane Both Here and Abroad. *Oil Gas J. 57,* 82 (1959) Mar. 9 (3 pp.)

First ocean shipment of liquid methane was unloaded at Canvey Island during the first week in March, but already there is competition for Venezuelan gas to be used in meeting demands in fuel-hungry areas of the world. Two companies have proposed to build liquefaction plants in Venezuela. One proposal was made in 1957 by Gases Licuados Constock, a subsidiary of Constock Liquid Methane Corp. A later proposal came from Hidrocarburos, S.A., a group formed by several U.S. companies. Both proposals are under consideration. First shipment may open door for Mideast and Venezuelan gas to compete in many areas of the U.S. So great is potential that W. R. Connole, vice chairman of the FPC, thinks natural gas in liquid form may pose an import problem rivaling that of foreign crude oil and products.

Gas Reaches Britain. *Oil Gas J. 57,* 88 (1959) Mar. 2.

Methane Pioneer arrived in England after a three-week voyage from Lake Charles, La. It docked at a terminal on Canvey Island between London and Southend with its cargo of 32,000 bbl. of liquid methane after a trip which encountered both good and bad weather. Cargo was transferred from the ship to storage tanks at Canvey Island and subsequently will be vaporized to gas under pressure and delivered to the reforming plant. There it will be mixed with refinery off-gases and the mixture reformed to town gas and delivered to N. Thames Gas Board's consumers in the London area.

Study Sahara Gas Tanker. *Petrol. Week 8,* 110 (1959) Feb. 20.

Four French companies, SN Repal, Cie Francaise des Petroles (Algerie), Creps and Petropar, backed by the French chemical giant, Air Liquide in a new research company, have announced plans to develop a liquid-methane tanker to transport Sahara natural gas. Company, called Soc. d'Etude du Transport et de la Valorization des Gas Naturels du Sahara (Segans), will start research in April at Villeras test station near Paris.

Petroleum Production

Cost Reduction: Homework for the Domestic Producer. L. F. McCollum. *Petrol. Eng. 31,* B-100 (1959) Feb. (6 pp.)

Domestic petroleum industry is caught between steadily rising costs and downward pressures on prices arising from the temporary abundance of crude oil supply in the Free World markets. Line of attack lies in an imaginative, vigorous program of cost reduction in all operational phases. Among other things means must be found to curtail unnecessary development drilling, to improve exploratory techniques, increase oil recovery and expand aggregate expenditures on scientific research.

Alaska Gas Line

Alaskan Gas Line Closer. *Oil Gas J. 57,* 74 (1959) Mar. 2.

Extensive expansion of Alaskan operations is planned by Colorado Oil & Gas Corp., Denver, with a 2-mile buffer-zone leasing predicted. Program may include a 402-mile natural gas line from the Gubik field to Fairbanks, costing more than $42 million.

Canadian Gas

Trans-Canada Completion to Bring Major Benefits to Canadian National Economy. *Gas Age 123,* 29 (1959) Feb. 5 (3 pp.)

Trans-Canada Pipelines Limited, which completed construction of its 2290-mile natural gas line from Alberta to Montreal in October, 1958, ahead of schedule, did so under estimated $375,000,000 cost. Trans-Canada is serving 11 distribution organizations and the expected maximum day demand during the 1958-59 heating season is estimated at 263,400 MCF daily sales compared with 195,800 MCF daily sales estimated in 1956, and estimated Canadian sales of about 820,000 MCF daily in the fifth year of operation. New line is expected to reduce Canadian energy import outlay by more than $50 million annually. In addition it will make country self-sufficient in sulfur supply and bring large additional capital investment in Western Canada.

Petrochemicals

Petrochemicals Production at Fawley. *Petrol. 22,* 50 (1959) Feb. (4 pp.)

Recently opened petrochemicals plant at Esso Petroleum Co.'s Fawley refinery will be able to produce 42,000 tons of butadiene each year, 40,000 tons of ethylene, 15,000 tons of heptenes, 28,000 tons of sulfur as well as other chemical feedstocks. This major addition to the petrochemical manufacturing facilities of the United Kingdom has been built at a cost of £10 million, bringing Esso's total expenditure on the Fawley refinery up to £68 million.

Butadiene

Butadiene—Brighter Horizons? C. A. Stokes, W. C. Franklin and L. J. Scofield. *Petrol. Eng. 31,* C-32 (1959) Feb. (2 pp.)

It can be said that as synthetic rubber goes, so goes butadiene. Even after three years in private hands, butadiene has found no new large-scale outlets as a chemical intermediate or even a monomer for elastomers other than SBR and NBR. Unfortunately for butadiene producers, this condition will almost surely continue for several years longer. Development for *cis*-polybutadiene as a substitute for natural rubber holds considerable promise but there are some forbidding technological barriers that have yet to be overcome.

Coal

Coal In Soil Fertility. N. R. Dhar. *Quarterly Bull. Central Fuel Research Inst. 8,* 2 (1958) Mar. (4 pp.)

Low productivity of Indian agriculture is bound to country's fuel habits. Fertilizer which should be earmarked for soil enrichment is being used for fuel. Scientists the world over have concluded that only 3% of world food production could be attributed to artificial fertilizers. Present Indian population of

400 million requires about 10 million tons of fixed nitrogen for self-sufficiency in food. Allahabad School of Soil Chemists has attacked problem of soil fertility by adding organic substances to the soil. In this process free nitrogen of the air is fixed. These researches have been conducted with all types of energy, producing materials like carbohydrates, glycerol, butter, ghee, lignin and various types of coals. They have been observed to be slowly oxidized in the soil with liberation of energy which is used in fixing atmospheric nitrogen. Basic slag from Tata Iron and Steel Co. contains 8-10% cf phosphorus as phosphorus pentoxide and that from Indian Iron & Steel Co. about 4%. Efficiency of fixing nitrogen by method described is 25-30%. Method adopted by Central Fuel Research Institute of India for preparing nitrogenous products from coal is promising.

Education

Report on Public High-School Course in Modern Engineering Physics. *Instruments and Control Systems 32,* 225 (1959) Feb. (8 pp.)

Academic, vocational and industrial leaders in Pittsburgh have combined forces to offer high school students a unique course in modern engineering physics, emphasizing instrumentation. Course impact is determined from reactions of 1) teacher, 2) students, 3) lecturers and 4) school system. Course encompasses every phase of physics; it complements and supplements the regular physics and chemistry courses but is not suggested as a substitute. Opposition to course has been noted to originate at university level. Outline of course curriculum is included.

Corrosion Mitigation. D. P. Price. *Gas 35,* 64 (1959) Mar (6 pp.)

Successful combatting of corrosion on a systemwide scale requires interest and assistance of all operating and installation men. Men must be schooled; a manual containing instructions and information on all phases of the cathodic protection and coating program is a necessity. Any means by which the corrosion program can be kept in the minds of operating personnel should be employed. Communications between the corrosion department, management and operating personnel is a must.

Safety

How One Utility Puts Safety First. K. W. Mitchell. *Can. Gas J. 52,* 13 (1959) Feb. (3 pp.)

Manager of Customer Service and Utilization and Measurement, Canadian Western Natural Gas Company Ltd., describes safety measures enforced by his company. Regulations followed include A.S.A. Code for Gas Transmission and Distribution piping, known as B31.18. Once line is in operation, constant vigil is used to assure that it remains gas tight. Company employs a staff of trained technicians and engineers to advise its customers on the safe use of its product and to inspect and recommend the proper type of equipment, both from the safety angle as well as the efficient use. To further this cause, company has operated an appliance testing laboratory for many years.

Maintenance

Refinery Maintenance Gets New Look. *Oil Gas J. 57,* 79 (1959) Mar. 9 (4 pp.)

Trend toward flexibility in work assignments and team approach while getting away from rigidity in craft rules is getting a push as pressure of fixed crude prices and fixed product prices forces refiners to trim operating costs.

2. ENERGY SUPPLY AND ECONOMICS

Gas Reserves

U.S. Natural Gas Reserves Climb to Record 254 Trillion Cubic Feet. (New York: A.G.A. Release No. 11-N9.) 1959 (Mar. 13.)

In a report released jointly with the API, the A.G.A. announced that proved recoverable reserves of natural gas in the U.S. climbed to an all-time high in 1958 of more than 254 million CF. A.G.A. notes that a net gain of 7.6 trillion CF was achieved during the year, even though net production in 1958 amounted to nearly 11.5 trillion CF, a one-year figure surpassed only by the all-time peak of 11,502 billion CF produced in 1957. Additions to natural gas reserves during 1958 totaled 19 trillion CF, including 5.6 trillion CF of new discoveries. Extensions and revisions of earlier estimates amounted to 13.4 trillion CF, and an increase of 58 billion CF was reported in underground storage. Nation's estimated proved recoverable reserves have increased from 173.9 trillion to 254.1 trillion CF since 1948. Total production during the same period was 92.4 trillion CF. New discoveries of natural gas liquids reserves in 1958 totaled 108.2 million barrels, second highest in the nation's history. Estimated reserves at year's end totaled 6.2 billion barrels, an increase of nearly 517 million barrels over the 1957 reserves total. Canadian natural gas reserves climbed to 23.3 trillion CF in 1958, compared with 20.7 trillion CF at the end of 1957, according to the Canadian Petroleum Association. Net production of 381 billion CF was reported against reserve additions of 2.9 trillion CF.

Gas Reserves Increasing but at Lower Rate than Gas Use. *World Oil 148,* 168 (1959) Feb. 15.

At the beginning of 1958, U.S. had an estimated proved natural gas reserve of 246.6 trillion CF, amounting to 8.8 trillion CF more than that reported at the start of 1957. In comparison, at the beginning of 1957, the U.S. recorded an estimated 237.8 trillion CF of proved gas reserves—14 trillion CF more than were reported at the start of 1956.

Energy Sources

Energy Supremacy. *Independent Petrol. Assoc. Monthly 29,* 16 (1959) Feb. (5 pp.)

Petroleum fuels continue to supply a larger and larger share of U.S. energy requirements. Oil and gas supplied only 18% of energy consumption in 1920; today, they supply about 70%. Expressed in crude oil equivalent, U.S. energy requirements in 1968 will total about 27 million barrels daily. Energy supremacy for the U.S. primarily depends upon discovery, development and availability of adequate petroleum fuels. This can be achieved only by increasing oil and gas exploration, drilling and development. Level of these essential activities will determine whether domestic petroleum reserves are expanded in keeping with growing national requirements. Ten-point program is suggested.

Nuclear or Solar Energy: Which Is More Practical for Space Heating? G. W. Rusler. *Heating, Piping & Air Conditioning 31,* 106 (1959) Feb. (4 pp.)

Solar energy—an "income" energy, could be a sizable source of heating fuel in the next 10-20 years if it were actively exploited starting now. This would help conserve some capital fuels for more critical energy uses. Nuclear energy can possibly become a major source of usable power and energy only after several decades of effort in solving the major health problems, in plant development and in building new facilities required. Over-all energy problem will be solved only through an immediate, vigorous, concerted effort on all energy fronts.

Recent Advances in Fluorine Chemistry and Technology. J. F. Gall. *ARS J. 29,* 95 (1959) Feb. (9 pp.)

Among all stable chemical materials, liquid fluorine oxidizer contributes the highest possible energy storage value, whether measured in terms of volume or weight. This is an outstanding reason for interest in fluorine chemistry. Such is the versatility of this chemistry, though, that fluorine chemicals other than liquid fluorine can substantially advance the art of high energy and storable propellants; furthermore, fluorine chemistry has given many compositions besides propellants useful in the unusual chemical and rigorous physical environments encountered in various parts of the rocket. Fortunately, fluorine chemistry has for some time been of interest in other major areas of technical advancement, including atomic energy generation, in steel making, oil refining, and in protection from corrosive or high temperature environments similar to those encountered in high performance rocketry. Advances which have been made in the last 10-15 years in fluorine chemistry have been timed with the requirements of rocket development.

Petroleum

The Case for 27½% Depletion. *Oil Gas J. 57,* 99 (1959) Feb. 23 (16 pp.)

This year Congress will consider two bills, each calling for a reduction in percentage depletion on oil and gas. The reduction sought is from 27½% to 15%. Article warns that cut in percentage depletion can only reduce country's ability to find more oil and gas to replace what is consumed each day. Special report was prepared because editors believe that most of the opposition to 27½% depletion stems from a lack of understanding of its objectives and its workings.

New, Mandatory Imports Plan Due Out This Week. *Oil Gas J. 57,* 84 (1959) Mar. 9 (2 pp.)

The President is expected to announce program based on refinery runs and setting total imports at about 1,100,000 bbl/d. Big importers will suffer in order to make room for 100 refiners not covered in voluntary plan. If new controls are effective, they are expected to have a steadying influence on shaky crude and products prices.

Petroleum Reserves

Oil Reserves Show First Drop in 14 Years. *World Oil 148,* 158 (1959) Feb. 15 (2 pp.)

U.S. proved petroleum reserves totaled slightly less than 36 billion bbl at the beginning of 1958, a decrease of 349.2 million barrels (0.97%) from the same period in 1957, for the first decrease since an 18.6 million deficit was reported in 1943. Crude accounted for 30.3 billion bbl of total liquid hydrocarbon reserves at the start of 1958, a decline of 134.2 million bbl from the same 1957 period. Natural gas liquid reserves decreased nearly 215 million bbl to a 5.7 billion bbl total. At current production rates, U.S. has a 12.4 year supply of proved recoverable liquid hydrocarbon reserves, the lowest ratio since 1948.

Sahara Wildcat Hits. *Oil Gas J. 57,* 84 (1959) Mar. 2.

Ste. Nationale des Petroles d'Acquitaine has a field discovery at El Gassi which could become a smaller

Hassi Messaoud. After a month's testing, SNPA revealed late in February the well flows at the rate of 2250 bbl/day on production tests of a 243-ft pay section found below 10,400 ft. Bottom-hole pressure is 6330 psi.

Fuel Cells

Fuel Cells. E. Gorin and H. L. Recht. ASME Paper No. 58-A-200. (New York: ASME, 1958); **Fuel Cells—Future Method of Conserving Natural Gas?** *Gas Age 123,* 38 (1959) Feb. 5 (3 pp.); *Mech. Eng. 81,* 63 (1959) Mar. (3 pp.)

Several different types of fuel cells have been under development. All cells for which any success has been claimed operate with gaseous fuels, and discussion is limited to these. Developments now underway on high temperature fuel cells and the electrical and thermal factors are briefly discussed. Authors' company is ultimately interested in use of solid fuels, particularly coal, which is by far most abundant fossil fuel for generation of power. Prior gasification of coal can be used to produce fuel gas for use in the fuel cell. This operation can be conducted in integration with the fuel cell process itself to produce a high potential efficiency for generation of power from coal as well as from other natural fuels.

Fuel Cells. G. J. Young and R. B. Rozelle. *J. Chem. Education 36,* 68 (1959) Feb. (6 pp.)

Fuel cells can most easily provide low voltage direct current and would be ideal power sources for electrometallurgical industries such as an aluminum refining plant. Other potential fuel sources may be found in the oil industries refining plants. Fuel cells should find many immediate applications as small power sources; however, the use of fuel cells for large scale power sources will depend on the economics of fuel gas supply, capital investment costs which are unknown at present, and future developments in fuel cells and competing nuclear and conventional electrical power plants. At present, large scale applicants appear to be limited to those unique situations that require direct current in areas of high electrical costs but with low cost sources of fuel gases.

Competitive Energy

Gas, Coke or Oil? E. G. Brooks. *Fuel Efficiency 7,* 13 (1959) Jan. (2 pp.)

Prices for three fuels, in relation to space heating, will vary up and down the country (England), but generally it will be found that gas is the most expensive and coke the cheapest. The very fact that all are in large-scale demand proves that to consider only fuel costs is wrong. Other factors are: Efficiency of combustion, capital cost, maintenance, space saving, supply and amenity.

Nuclear Energy

Free-World Engineers Map New Heavy Water Processes and Plants for Nuclear Future. *Chem. Eng. 66,* 64 (1959) Feb. 23 (3 pp.)

To give domestic nuclear power the heavy water it needs, at a price it can afford, engineers are striving to domesticate production technology born out of military necessity. Currently, the AEC Savannah River plant offers the only U.S. source of heavy water which is sold to qualified customers in quantities up to 400 lb at $28/lb or 4%/yr rental charge. Plant uses three processes in combination: Dual-temperature exchange, water distillation and electrolysis. Entering dual-temperature process, water undergoes deuterium enrichment from contact with H_2S-D_2S mixture at lower temperature. Some of this enriched water passes to low-temperature tower for further enrichment. Water discharging from the dual-temperature exchange contains 15-20% D_2O. Water undergoes distillation to raise D_2O content to 90%. Electrolysis completes final concentration to 99.8% D_2O.

Process Heat from Nuclear Reactors. H. Perry and J. P. McGee. *Chem. Eng. 66,* 143 (1959) Feb. 23 (4 pp.)

Bureau of Mines has given consideration to the comparative economics of using nuclear energy instead of using conventional fuels for supplying process heat in these operations: Reforming methane to hydrogen; coal gasification; low-temperature carbonization of coal; ferrous and nonferrous metallurgy; petroleum refining; production of acetylene, and direct fixation of nitrogen. Article presents some conclusions based on this work.

America Is at the Crossroads in Nuclear Power. C. D. Matthews. *Public Util. Fortnightly 63,* 307 (1959) Feb. 26 (7 pp.)

Expanded nuclear power program sponsored by the Joint Committee on Atomic Energy appears to favor emasculating the initiative of industry and adding more government controls. And, unless "second generation" plants are more explicitly defined, it would seem that the plan would force free enterprise to take a back seat to government enterprise. Nevertheless a workable program can still be developed if the Joint Committee, AEC and industry will pool their thinking and efforts. Main objectives should be: 1) Demonstration of economically competitive electric power in U. S. by 1970 and in high fuel cost allied nations by 1968; 2) fortification of U. S. position of leadership in peaceful uses of nuclear energy, particularly with regard to power.

3. NATURAL GAS AND PETROLEUM PRODUCTION

Drilling Mud

Analyzing Mud Solids Saves Time and Money. P. W. Cooke. *World Oil 148,* 66 (1959) Feb. 1 (4 pp.)

Drilled clay solids concentration in mud, especially when penetrating mud-making formations, is main factor influencing viscosity. Purpose of the more common treating chemicals is to enable the mud to tolerate more drilled solids without losing desired qualities of viscosity and fluid loss. Chemical effectiveness goes only so far and then it becomes expedient to reduce the clay solids concentration to avoid excessive viscosity rises. This may be accomplished either by watering-back and reweighing, or, preferably, by application of centrifuges and cyclones which discard the undesirable clay solids from a weighted mud without removing the weight material.

Exploration

Argentine Activity Hits Feverish Pace. *Petrol. Eng. 31,* B-73 (1959) Feb. (3 pp.)

Most recent of the significant developments is the delivery from Italy of the largest number of identical drilling rigs ever destined for one area. When order is complete, 30 identical rigs will be at work in the Comodoro Rivadavia area drilling for Yacimientos Petroliferos Fiscales, the national oil company. Twenty of the dual trailer-mounted rigs are being shipped from Italy; ten from a Beaumont, Texas, plant were shipped in 1957. Order for new drilling equipment is just one phase of Argentina's crash program to fill the country's rising oil needs from domestic reserves.

Are We Missing Carbonate Pools? J. T. Bado. *Oil Gas J. 57,* 208 (1959) Feb. 16 (5 pp.)

North McWillie field (Okla.) cannot be classified as a major oil-field discovery, but it has indicated that a new look at the prospective carbonate pays in the area must be undertaken. Field is discussed in article as a carbonate-type field.

In Exploration, the Problems Are Tougher, Incentives Are Weaker. *Petrol. Week 8,* 42 (1959) Mar. 13 (10 pp.)

While need for new petroleum reserves grows more crucial, difficulties in finding them are increasing and incentive (profit) is decreasing. Unless some completely new techniques are developed, it is concluded that present methods will have to be used in combination if remaining reservoirs are to be pinpointed, and this may mean that the day of the specialist is over. Insofar as equipment is concerned, some of it is so advanced that "old timers" are having trouble understanding how it works. On the exploratory front, geophysical activity is at a low ebb, but should fare better in 1959 than in 1958. Other trends: Geophysical equipment is getting smaller, more portable; there is a stronger effort to correlate all available knowledge; extra-deep exploratory drill probably will be a rarity, unless economic climate improves; number of exploratory companies active in foreign countries will continue to increase.

Logging

Displacement Logging: A New Concept in Resistivity Logging. W. C. Pritchett. *Petrol. Eng. 31,* B-56 (1959) Feb. (5 pp.)

New instrument under laboratory development responds directly to presence of producible oil but does not to presence of residual oil; experimental tests verified, work continues toward acceptable field tool.

Radioactivity Logs for Gas Location. D. H. McLendon. *World Oil 148,* 79 (1959) Feb. 1 (6 pp.)

When it is advantageous to locate gas in a drill hole, radioactivity log yet has to be surpassed for reliability and ease of interpretation. In some cases it fails to give desired result due to conditions of deep fluid invasion, etc. On the whole, however, radioactivity log is recognized as best gas log available. Improved instrumentation, ability to log wells under flowing conditions and a better understanding of subsurface conditions are constantly improving success ratios.

Well Logging: Today and Tomorrow. A. J. Pearson. *Petrol. Eng. 31,* B-33 (1959) Feb. (11 pp.)

Present logs help find oil, guide testing and aid reservoir engineer. Through use of electric logs, additional oil can be discovered . . . as well as oil and gas reservoirs that might otherwise be overlooked. Method is economical . . . well logs indicate which zones are to be tested and how to test and complete a given well. Most reservoir engineering studies begin with study of electrical and nuclear logs. Yet unsolved logging problems remain. Log combinations, a new porosity tool and computers promise more, better answers.

Offshore Operations

Offshore's Oil Industry Is Flexing Its Muscles Again. *Petrol. Week 8,* 54 (1959) Feb. 20 (15 pp.)

For the first time in 18 months, outlook for offshore activities has brightened. Reason: Sharply rising production of gas and condensate makes area appear more inviting. Drilling during 1959 should strike somewhere between the 1957 and 1958 rates.

That would bring total completions in 1959 to between 600 and 700 wells off Louisiana alone. Other offshore activity will take place off California, Texas and Florida. Several pipeline projects will add substantially to the offshore transportation picture in 1959—again, especially in the gas phase. Companies involved in the several projects are Transcontinental Gas Pipe Line Corp., Tennessee Gas Transmission Co., Trunkline Gas Co., and Columbia Gulf Transmission Co.

Reservoir Engineering

Developments in Natural Gas Reservoir Engineering. M. R. Tek. *Petrol. Eng. 31,* B-47 (1959) Mar. (3 pp.)

Gas production engineering problems still lie in mathematics of gas flow through porous media. Use of finite difference math and digital computing techniques provides answers for specific problems . . . but a complete partial differential equation explaining true flow phenomena has not yet been offered. Bibliography cites articles of last decade.

Material Balance Equations for Gas Reservoirs with Water Drive. J. R. Fraser and A. E. Campbell. *World Oil 148,* 63 (1959) Feb. 1 (3 pp.)

Reasonable estimate of original reserves in a reservoir and the degree of water drive may be determined by application of a material balance equation in conjunction with a water influx equation. These basic concepts and their applications have been discussed by various investigators. However, most of these discussions refer rather specifically to oil reservoirs, although the fundamental principles apply to gas and gas-condensate reservoirs with equal significance and ultimate benefit. Based on these considerations, a simple material balance equation for gas reservoirs has been combined with the Schilthuis water influx equation.

Secondary Recovery

Miscible-phase Floods May Precipitate Asphalt. R. B. Bossler and P. B. Crawford. *Oil Gas J. 57,* 137 (199) Feb. 23 (6 pp.)

Ability of LPG to precipitate asphalts, waxes and heavy lube oils from crudes sounds a warning to operators planning a miscible-phase flood. Tendency toward precipitation decreases as the molecular weight of injected miscible fluid increases. Precipitated asphalt or heavy material may result in disastrous effects on field experiments. Article covers conditions under which precipitation may be encountered.

Well Practice

Needed: Wider Well Spacing. R. M. Williams. *World Oil 148,* 98 (1959) Feb. 1 (4 pp.)

Excess wells unnecessarily occupy and damage landowner's surface. The more wells, the greater the risk of improper completions and inefficient wells. The lower the per wells allowable, the less likely a producer is to do the proper remedial work. Suggested three-step solution to well spacing problem is: 1) Establishment of an initial spacing pattern for development purposes, whether it be by statewide order or for each area of development; 2) establishment of a system for holding further hearings to determine optimum spacing after enough wells had been drilled and when required information and evidence were available, and 3) empowering a regulatory agency with authority to permit infill drilling and closer spacing if more wells are indicated either by spacing reevaluation or a need for an increased current rate of production.

Use of Small Diameter Casing Reduces Well Costs. M. H. Stekoll and W. L. Hodges. *World Oil 148,* 70 (1959) Feb. 1 (5 pp.)

Stekoll Petroleum Company has reduced well completion costs by setting 2⅞-in. casing (oil strings) in lieu of larger pipe. One-inch tubing also is used in these slim hole completions in place of conventional rod and tubing strings. Comparisons of well costs indicate that a typical 5000-foot well will cost $7500-$8500 less when equipped with 2⅞-in. casing than a well completed with 5½-in. pipe. This saving means that enough money is saved to drill another well with approximately every seven wells drilled.

Well Productivity

Various Methods Used in Comparison of Productivity Tests on a Large-Capacity Gas Well. J. S. Miller, C. J. Walker and H. N. Dunning. *Petrol. Eng. 31,* B-23 (1959) Feb. (4 pp.)

Theoretical production of gas well stabilization usually requires reservoir data not always available. Description of series of tests which include 1) conventional back-pressure tests of increasing and decreasing rate sequence; 2) isochronal performance tests of increasing rate sequence, and 3) extended period flow tests.

Reservoir Engineering

Method of Measuring Characteristics of Porous Material. J. S. Aronofsky, G. C. Wallick and P. P. Reichertz (assigned to Socony Mobil Oil Co.) U.S. 2,867,116 (1959) Jan. 6.

Gas slip permeability and porosity of a porous material (reservoir rock) are determined by sealing a

sample in a chamber between a high pressure gas supply and a low pressure source, sealing up a high pressure at one end wall of sample, measuring time required for pressure to fall to a predetermined value, repeating the pressure drop procedure with with different initial values and using these experimental time-pressure values in the D'Arcy equation for calculations.

Secondary Recovery

Production of Hydrocarbon Material. C. F. Weinaug and D. Ling (assigned to Univ. of Kansas Research Foundation). U.S. 2,867,277 (1959) Jan. 6.

In a process for petroleum recovery by fluid displacement, one premixed fluid of petroleum and a lower-viscosity hydrocarbon (propane, LPG) is injected and then followed by injection of regular hydrocarbon displacement fluid, the mixture forming a transition zone to avoid irregular advance of the displacement drive. Several premixed intermediate fluids of progressively lower viscosity down to natural gas may be used.

4. GAS CONDITIONING AND LPG RECOVERY

Dust Removal

Trouble-Shooting Mechanical Dust Collectors. W. E. Archer. ASME Paper No. 58-A-283. (New York: ASME, 1958.)

Preventive and corrective maintenance for mechanical dust collectors cannot be reduced to a fixed formula. Variation in material being collected, from one installation to another, variation in layout, in operating techniques and in-plant maintenance practices, all may seriously affect collector performance. Gas and dust distribution, plugging and wear constitute the greatest part of mechanical-collector difficulties. Solutions are to be found primarily through a common-sense approach and a knowledge of the fundamental operating principles of mechanical collectors.

Gasoline

Second Stage of Lacq Plant Complete. *Petrol. Refiner 38,* 174 (1959) Feb. (4 pp.)

Second stage of the natural gasoline plant at Lacq field in Southern France went partially on stream in October, 1958. Second stage will process about 140 MMCF of raw gas daily, producing about 85 MMCF of processed pipeline gas, 800 metric tons of sulfur, 1100 bbl/d of natural gasoline and about 600 bbl/d of propane. Butane and ethane are produced in quantity also. Societe Nationale des Petroles d'Aquitaine (SNPA), the French government company holding the Lacq field concession, had the third stage under construction and has reportedly been discussing construction contract tenders for a fourth.

Hydrogen Sulfide Removal

Solubility of Acidic Gases in Aqueous Monoethanolamine. J. H. Jones, H. R. Froning and E. E. Claytor, Jr. *J. Chem. Eng. Data 4,* 85 (1959) Jan. (8 pp.)

Study provides accurate solubility data for the system carbon dioxide-hydrogen sulfide-15.3 weight % MEA over temperature and concentration ranges of particular interest in the design and operation of amine units. An empirical correlation is presented by which either the solution loading or vapor composition of an equilibrium system can be obtained when the composition of either phase is known.

Water Washing for Acid Gas Removal. J. G. Burnham. *Petrol. Eng. 31,* C-15 (1959) Feb. (4 pp.)

Difficulties of sweetening gas have been with oil and gas industry for numerous years. In recent times, concentrations in sour gases have generally increased and 20-30% or more CO_2 or 20-30% H_2S in raw gas is not uncommon. Canada, for example, seems unable to discover a field without a high level of H_2S. Question of how to treat high acid gas concentrations economically is apt to become more acute with time. Recent installations and studies have shown "Aquasorption" to be a practical process for gas sweetening, particularly with high H_2S to CO_2 ratio. Article gives complete design and economics report.

Organic Sulfur

Identification and Determination of Organic Sulfur in Utility Gases. D. McA. Mason and H. Hakewill, Jr. (Chicago: Institute of Gas Technology, Research Bull. No. 5. Jan. 1959.)

Bulletin presents analytical methods and detailed descriptions of apparatus for accurately determining types and amounts of organic sulfur compounds in utility and synthesis gases. Methods described have sufficient sensitivity to permit determination of sulfur compounds in concentrations of less than one grain per hundred cubic feet of gas.

Organic Sulfur Removal

Town Gas Desulphurisation by Oil Washing. R. Fleming and P. G. Harris. *Gas J. 297,* 100 (1959) Jan. 21 (6 pp.)

Desulfurizing plant for the East Midlands Gas Board (England), Car House works, which is complete in

two units, is designed for 95% benzole removal and 90% extraction of the organic sulfur compounds which are removable by oil washing from 13.5 MMCF/day of coal gas from intermittent vertical chambers, 3-5 MMCF/day of crude coke oven gas and up to 4 MMCF/day of carburetted water gas.

Hydrocarbon Recovery

Recovery of Hydrocarbons from Gases. F. E. Gilmore (assigned to Phillips Petrol. Co.) U.S. 2,868,326 (1959) Jan. 13.

Propane and propylenes, together with some hydrogen sulfide, are recovered from a hydrocarbon gas stream by a process comprising 1) scrubbing the gases with an absorption oil; 2) scrubbing the oil in a separate contactor with water or immiscible solvent for H_2S to provide substantially purified oil, and 3) separating oil and water and recovering hydrocarbon from the oil by fractionation.

Hydrogen Sulfide Removal

Method of Gas Purification Utilizing an Amine Solution and an Anti-Corrosion Agent. P. W. Fischer (assigned to Union Oil Co. of Calif.) U.S. 2,869,978 (1959) Jan. 20.

Improved solution for purification of gas, non-corrosive to iron, is obtained in an alkanol amine scrubbing solution by adding 0.05-0.5% antimony tartrate to the solution and sufficient alkali metal hydroxide to maintain a *p*H of 3.0-4.5.

Removing Hydrogen Sulphide from Gases. J. E. Mills (assigned to The Gas Council). U.S. 2,868,617 (1959) Jan. 6.

In removal of hydrogen sulfide from a mixture of gases, an improved process is claimed which comprises washing the crude gas with a solution of a dye base of the azine or triphenylmethane class. H_2S reacts to form the leuco base of the dye. Leuco base then is contacted with oxygen and regenerated to the original base for reuse.

5. NATURAL GAS TRANSMISSION

Automation

Mechanical Type of Indicator Relay System for Engine or Compressor Shutdowns. *Pipe Line News 31,* 57 (1959) Feb. (3 pp.)

In many pipeline installations it has been found desirable to employ some type of mechanical indicator which can pinpoint the cause of shutdown. Article describes the Amot Model 2400 indicating relay in combination with the Amot safety control systems. This is a mechanical method of indicating which safety control component caused the engine shutdown. One indicating relay is used for each component and only the window shows on the panel board.

Communications

A New Method of Pipeline Communications. F. V. Long. *Gas 35,* 140 (1959) Mar. (2 pp.)

Means of good reliable effective communications is use of buried metallic coaxial transmission line. Author lists six arguments against its use and refutes them.

Compressors

Application of Variable Speed Electric Drive to Compressors, Boosters and Exhausters for Use in Gas Works. H. K. Nicholas. *Gas World 149,* 214 (1959) Jan. 24 (6 pp.); *Gas J. 297,* 143 (1959) Jan. 28 (6 pp.)

Discussion of various methods of moving gas in bulk from one point to another and description of the type of variable speed electric motor which has been developed to perform these and similar duties. Attempt is made to discuss suitability of each of the types for each duty and to illustrate the facility with which output pressure or gas flow may be controlled when electric drive is used.

Compressor Stations

Solving Gas-Pulsation Problems. R. E. Mayne. *Oil Gas J. 57,* 123 (1959) Mar. 9 (5 pp.)

Electro-acoustical analog has been used by Northern Natural Gas Co. to obtain 27 individual piping designs that have been installed on 79 compressor engines. Analog, which simulates actions of compressor and piping, is alleviating gas pulsation.

TET Adds Horsepower at Holbrook. W. Woods. *Oil Gas J. 57,* 132 (1959) Mar. 9 (4 pp.)

Proper expansion of a compressor station can result in a considerable savings in both the initial cost and the operating expenses afterward. Thoughtful planning is required along with careful consideration toward future expansion. Expansion described is not conventional. Rather, it represents a bold design attack on a station which had already been expanded perhaps beyond concept of original designer.

Engines

Engine Analyzer Spots Trouble in the Making. M. G. Wallington. *Oil Gas J. 57,* 133 (1959) Feb. 16 (3 pp.)

Electronic analyzer has proved to be an excellent maintenance tool on spark-ignited gas engines. While an engine is in operation, it is possible to analyze its mechanical condition. Three distinct tests conducted using the engine analyzer are: 1) Ignition, 2) vibration and 3) pressure.

Metering

Effect of Entrained Liquids on Gas Measurement. R. A. Schuster. *Pipe Line Ind. 10,* 24 (1959) Feb. (6 pp.)

It was believed that if the effects of a liquid upon gas measurement could be determined accurately, a correction factor could be calculated; a curve could be drawn plotting the percent error against the liquid content in applicable terms, such as barrels of water per million CF of gas. Then, if the liquid content was known, the percent of measurement error could be obtained from the curve: the recorded volume could be adjusted to more accurately indicate the true volume. Full-scale orifice meter installations were used, in 3- and 4-in. sizes, to conduct a series of tests to determine if a correlation could be established between dry gas measurement and varying amounts of liquids with regard to true measurement. Tests were planned at various liquid rates, liquid specific gravities, gas rates and pressures as well as different orifice sizes.

New Method Simplifies Orifice-Meter-Chart Calculations. R. J. Enright. *Oil Gas J. 57,* 138 (1959) Feb. 16 (3 pp.)

New electronic computing typewriter can produce a chart calculation rapidly, verify and automatically print out results on the back of the chart together with all derivative factors, within 10-15 seconds.

Pipeline Construction

Computer Aids for the Pipe Line Engineer. T. R. Young. Part 1. *Pipe Line Ind. 9,* 23 (1958) Dec. (4 pp.); Part 2. *Ibid. 10,* 50 (1959) Feb. (6 pp.)

Electronic equipment today has many capabilities not being used fully for solution of pipeline engineering and operating problems. Many engineers need a better understanding of the methods for adapting their problems to computer programming. Understanding application of the electronic computer in logical operations opens up many possibilities in pipeline engineering. Typical solutions include those for design properties of pipe and pressure drop handbook calculations.

Pipeline Mapping with Aerial Photos. R. L. Gohman. *Oil Gas J. 57,* 152 (1959) Mar. 9 (6 pp.)

Unique application of advantages of aerial photography was made during construction of the Pacific Northwest Pipeline project because of the difficult terrain and the tight construction schedule. While aerial photography itself was not new in industry and values of controlled aerial mosaics was recognized, Pacific could not justify a survey to establish ground control points. Instead, the objective was to eliminate as much field work as possible and at the same time reproduce photographs, along with certain pertinent information, in such a way as to furnish all personnel with a suitable working copy almost immediately. Procedure, which also has been adapted by Pacific for gathering systems, is described.

Saving Money with Mechanical Anchors. W. Hollander. *Pipe Line Ind.* 10, 35 (1959) Feb. (3 pp.)

Many of the 25,000 plus miles of pipeline scheduled for construction in 1959 must be protected against flotation. Low cost, screw type earth anchors, especially adapted for pipeline application, are now being used by many major pipeline companies. Anchoring by this means is achieved by screwing an anchor into firm subsoil on each side of the pipe and attaching them to the pipe by means of a preformed saddle bracket. Pad of rock shield or other non-corrosive material is used under the bracket to protect the coating and insulate the anchors from static current in the line.

Second Vancouver Pipeline. *Can. Gas J. 52,* 33 (1959) Feb. (2 pp.)

Construction of a second pipeline to bring natural gas into metropolitan Vancouver, costing about $500,000, was completed in December. British Columbia Electric's ability to deliver gas to this district has been increased by 2 million CF/hr. Main areas to benefit directly from completion of this 19½-mile pipeline were the north end of Vancouver and the north shore of Burard Inlet. B. C. Electric buys Peace River natural gas from Westcoast Transmission Co. at Huntingdon, B. C., south of the Fraser River some 45 miles from Vancouver.

Pipeline Operations

Europe's Longest Big-Inch Line Starts Operation. O. Anderson. *Pipe Line Ind. 10,* 41 (1959) Feb. (3 pp.)

Ruhrgas AG, Essen, used modern methods in laying the 230-mile, 28-in. line from North Sea port of Wilhelmshaven to the Ruhr. Number of waterways, roads, underground piping and cable installations plus cultivated German farmland had to be crossed and restored. Initially the line, operated by Northwest Oil Pipe Line Company, will deliver up to 200,000 bbl/d to Rhur refineries. Plans call for ultimate expansion with three unattended pump stations to boost capacity to nearly 500,000 bbl/d.

Pipeline Systems

The Florida Pipeline—A New Concept in Gas Transmission. P. Reed and G. Kinney. *Oil Gas J. 57,* 108 (1959) Mar. 9 (9 pp.)

Line backers departed from standard pattern by direct producer consumer sales for most of the load, making tight supply available, opening big market; heavy industrial load to offset low heating market, permitting economic line operation; a new type of structure for uniformity and design and construction innovations. Operation of the 2596-mile pipeline system from the Rio Grande Valley of Texas to Miami, Fla., built at a cost of $163,757,000, will start June 1.

The Trans-Canada Pipe Line System. *Pipe Line News 31,* 22 (1959) Feb. (21 pp.)

Comprehensive history of the 2294-mile natural gas pipeline from Alberta to Montreal (Canada) discusses merger of Trans-Canada with Western Pipe Lines, Ltd.; land acquisition; problems of the crossings at Niagara River and the Welland Canal; use of a double jointing yard; terrain east of Winnipeg; use of drilling barges; work of 12 construction spreads to lay 853 miles of 30-in. pipe from the Lakehead to Maple, near Toronto; construction of six of the planned 27 compressor stations in 1958; anticipated increase in gas demand and a listing of the officers and offices of the company.

Welding

Consider These Factors in Fabricating Branch Connections. R. S. Ryan. *Oil Gas J. 57,* 117 (1959) Mar. 9 (3 pp.)

Article describes some fundamental principles of welding and how shrinkage stresses can introduce distortion, residual stress and stress concentration. These principles are used as a basis for the specific application of branch connections in the development of a sequence for welding various types of branch connections. Shrinkage stresses can be used beneficially to produce the best fit-up and minimize the detrimental effect of residual stresses and stress concentration.

6. GAS AND LPG STORAGE

Gas Holders

Low Pressure Gas Holders and the DVGW Guide. H. K. Kessler. *Gas u. Wasserfach 100,* 49 (1959) Jan. 16 (9 pp. German text.)

Review of recent growth of West German holder capacity. Basic designs of the frame- and spiral-guided, as well as piston-type, holders are discussed with mention of principles of water and oil seals, tangential and radial bracing and basin-tank and piping arrangements. Design and safety details of cups are discussed. Application and value of the DVGW specifications are emphasized.

Underground Storage

Comparison of Refrigerated and Mined LP-Gas Storage. P. W. Tucker and C. C. Anderson. *LP-Gas 19,* 48 (1959) Mar. (5 pp.)

Three basic plans may be employed for economic storage of LPG: 1) Injection into depleted oil reservoirs, 2) storage in salt cavities; 3) storage in mined caverns and 4) refrigerated storage. So many variations are available that the precise, practical deduced decision is predicated on the complete evaluation of the influencing factors as climate, insulation, power, filling rate, throughput and tender sizes. Practical plan may be selected for each situation. Future will see more bulk movement of LPG and more bulk storage of LPG. Economics will dictate that it will be larger.

Giant Storage Enables Sendouts Ranging from 150 to 1,270 M.M.c.f.d. R. B. Batten and J. R. Elenbaaf. *Oil Gas J. 57,* 164 (1959) Mar. 9 (5 pp.)

Some 855,000 customers in Michigan are served by Michigan Consolidated Gas Co. In 1953, company completed acquisition of the interests in the depleted Six Lakes gas field and started developing the field for storage. This field enables company to gain flexibility to supply widely varying needs of its customers (from 150,000 MCF/d on a warm summer weekend to 1,274,000 MCF/d on a cold day in January). Article describes development of field, present operations and compressor station.

Hebron Storage Field Pays Off. E. S. Murray and T. S. Park, Jr. *Oil Gas J. 57,* 142 (1959) Mar. 9 (5 pp.)

Storage facility operated by Tennessee Gas Pipeline Co. 45 miles south of Olean, N.Y., makes available an ample volume of pipeline-quality gas for winter loads. In the past 4½ years it has been possible to store approximately 58 billion CF of gas for winter marketing at field pressures up to 2200 psi in Hebron field. Field is jointly operated with United Natural Gas Co. of Oil City, Pa. Storage area, near Coudersport, Pa., is within 300 miles of the ultimate customers, and is tantamount to having a high-pressure gas field on tap and ready for convenient delivery to the system's customers. Dependability of the mechanical facilities and the availability of this large volume of gas close to market makes for economy and convenience that cannot be entirely evaluated in monetary terms.

Income Tax Problems in Connections with Underground Storage. D. E. Lennon. *Gas Age 123,* 32 (1959) Feb. 5 (5 pp.)

Most of the income tax problems in connection with underground storage are not fundamentally different from those which arise in connection with other utility operations and with other types of business. However, unique nature of a storage operation does create some unique tax problems. To a considerable extent, the special problems arise because industry practice and general tax practice differ. Most of the special problems are too new to have been litigated, and in most cases the Internal Revenue Service has not fixed its position. Gas inventory accounting, depletion and depreciation give rise to most of the special tax problems which are encountered in connection with storage operations. Article discusses these subjects.

Underground Storage

Method and Apparatus for Operating Underground Storage Caverns. R. M. Gibson, K. C. Brink and A. M. Shook (assigned to The Texas Co.) U. S. 2,869,328 (1959) Jan. 20.

Operation of a hydrocarbon underground storage cavern by displacement of fuel by a strong brine is improved by addition of dilution water to the outflowing brine to prevent precipitation and blocking of conduits by salt.

7. MANUFACTURED GAS AND CHEMICAL PROCESSING

Ammonia

Ammonia Plant Is Compact, Flexible. J. O. Hartman and C. F. Mackey. *Oil Gas J. 57,* 100 (1959) Mar. 2 (4 pp.)

Design capacity of the PCI ammonia plant at Lake Charles, La., is 100,000 short tons of anhydrous ammonia annually. Plant uses infrared analyzers to monitor acetylene in the butadiene feed gas and to measure hydrocarbons in the intake air, acetylene in oxygen and ethylene in oxygen. These analyzers have performed well in service and have contributed appreciably to over-all safety in operation of the low temperature facilities. Nitrogen scrubbing unit or LTSU makes pure synthesis gas, a separate methane gas stream, a separate stream of ethane plus heavier hydrocarbons and a CO fraction. Methane fraction goes to the PCI fuel-gas system and the ethane-plus fraction is delivered as a feed gas to the ethylene plant. The CO goes to flare. The LTSU is designed to produce ammonia synthesis gas containing less than 20 ppm of total impurities (CO plus O_2). It is rated at the ammonia equivalent of 310 tons/day.

Carbonization

The Process of Fissuring in Coke and the Mechanism of Coke Formation. J. Nadziakiewicz. *Coke and Gas 21,* 46 (1959) Feb. (10 pp.)

Mechanical strength of industrial coke is determined by the fissures. When subjected to mechanical forces, coke breaks into smaller pieces along these fissures. Fissures arise in coke as a result of decrease in volume between bulk volume of granulated coal and resulting true volume of the coke (without fissures). This reduction in volume takes place in two periods. First is the period from the beginning of heating to the end of the plastic stage, i.e., to about 500°C, and the second period from about 500°C to the end of the process, to about 1000°C.

Catalysts

Carbon Formation from Carbon Monoxide-Hydrogen Mixtures over Iron Catalysts. I. Properties of Carbon Formed. P. L. Walker Jr., J. F. Rakszawski and G. R. Imperial. *J. Phys. Chem. 63,* 133 (1959) Feb. (8 pp.)

Properties of carbons formed from various carbon monoxide-hydrogen mixtures in a flow system over iron catalysts at temperatures from 450-700° and atmospheric pressure have been investigated. Crystallite height, surface area, C-H ratio and electrical resistivity of carbons are found to be markedly affected by formation temperature, gas composition and amount of carbon formed over the catalyst. Carbons have an unusually well developed crystalline character, considering the relatively low formation temperatures, with crystallite heights in most cases being above 100 A, and interlayer spacings indicating substantial three-dimensional ordering.

Carbon Formation from Carbon Monoxide-Hydrogen Mixtures over Iron Catalysts. II. Rates of Carbon Formation. P. L. Walker, Jr., J. F. Rakszawski and G. R. Imperial. *J. Phys. Chem. 63,* 140 (1959) Feb. (10 pp.)

Effect of temperature and inlet carbon monoxide-hydrogen composition on the rate of carbon formation and amount of carbon which can be formed over iron catalysts before the catalysts are deactivated has been investigated. As the hydrogen content of the gas mixture is increased, the temperature at which the maximum rate of carbon deposition occurs also increases. Change in mixture composition has a relatively small effect on rate of carbon deposition or total amount of carbon which can be formed from

a given catalyst weight at lower temperatures (470-528°) but has a major effect at higher temperatures (above *ca* 576°). At the higher temperatures, maximum rate of carbon formation increases with increasing hydrogen content in the gas up to a point and then decreases. Also, increases in hydrogen content of the gas markedly increase the total amount of carbon which can be formed before catalyst deactivation occurs. Type of catalyst pretreatment and nature of catalyst also affects carbon deposition.

Coal

Contribution to the Explanation of the Structure and Constitution of Coal. M. S. Iyengar and A. Lahiri. *Brennstoff-Chemie 40*, 8 (1959) Jan. 21 (6 pp. German text.)

Various conclusions are drawn from assembled researches on coal reactive groups, sorption of vapors, X-ray diffraction, oxidation, briquetting and carbonization and the Central Fuel Research Institute of India.

Ethylene

PCI's Ethylene Plant Features High-Efficiency, Low-Temperature Process. W. Tucker, C. G. Kevil and P. M. Ableson. *Oil Gas J. 57*, 94 (1959) Mar. 2. (6 pp.)

High purity (99.7-plus %) ethylene is made with single demethanizer and single ethylene fractionator. Plant has consistently exceeded specified ethylene purity. Offgases are produced in two streams, one rich in hydrogen and the other in methane. PCI recovery section consists of: 1) Fractionation to separate C_3 and heavier from C_2 and lighter materials; 2) low-temperature condensation at high pressure to liquefy all of the C_2's, and 3) demethanization of the condensed liquid at low pressure. PCI plant thus would be classified as a low-pressure, low-temperature fractionation plant.

Study of the Effect of Steam on Pyrolysis of a Commercial Ethane Fraction for the Production of Ethylene. P. S. Kogan and L. A. Potolovskii. *Khim. Tekh. Top Masel. 3*, 22 (1958) No. 12 (5 pp. Russian text.)

Effect of steam-to-feed ratio and residence time was studied. Coke yield much reduced.

Assoc. Tech. Services, Inc.

Gasification

A Study of the Reactions of Graphite with Carbon Dioxide with Reference to Gas-Cooled Nuclear Reactors. T. B. Copestake, H. W. Davidson and B. L. Tonge. *J. Appl. Chem. 9*, 74 (1959) Feb. (11 pp.)

Reaction of graphite and carbon dioxide is discussed in relation to the performance and safety of gas-cooled graphite-moderated nuclear reactors. Reaction is promoted by reactor radiation but this radiation-induced process is unlikely to be temperature dependent. Limiting temperature for operating the system graphite-carbon dioxide is, therefore, probably set by the thermal reaction. Wide variety of experimental means has been used to examine the thermal reaction and it is concluded that gasification of carbon by carbon dioxide is unlikely below temperatures of 600°. This conclusion appears valid even if applied to graphite which has undergone heavy neutron damage. Accelerated life tests covering several thousand hours have been used to confirm these observations. These same tests show that gasification of graphite occurs at temperatures above 600° but it is strongly inhibited by carbon monoxide. This provides an additional factor of safety from the reactor point of view. Most pessimistic estimate for the rate of gasification of graphite in carbon dioxide by purely thermal means at 500° is calculated to be 0.1% (by weight) in 20 years.

Hydrogen

Technology Newsletter. *Chem. Week 84*, 49 (1959) Feb. 28 (2 pp.)

Article briefly discusses proposed new $6-million liquid hydrogen plant to be built in western U.S. to turn out 10,000 lb/day. Present U.S. production figures are not available, but biggest plant is believed to be that built by Air Products in the Cape Canaveral area, capable of making 500,000 lb/year. Manufacture and storage of liquid hydrogen poses formidable engineering problem. Air Products plant is thought to use a liquid helium or similar approach; Messer in Germany is pilot-planting an expansion engine approach.

Hydrogenation

Hydrogenation of Heavy Petroleum Residues and Secondary Distillates. V. I. Karzhev et al. *Khim. Tekh. Top. Masel 3*, 3 (1958) No. 12 (7 pp. Russian text.)

Fixed-bed hydrogenation shown to raise yields of light products, broaden their range and improve quality.

Assoc. Tech. Services, Inc.

Preparation of Products with a High Content of Aromatic Hydrocarbons by Hydrogenation. N. V. Goncharov et al. *Khim. Tekh. Top. Masel 3*, 15 (1958) No. 12 (7 pp. Russian text.)

Optimum conditions for vapor-phase hydrogenation of catalytically cracked gas oil and hydrogenated semicoke tar with maximum production of aromatics are established.

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Liquefaction

On the Optimum Conditions in an Isenthalpic Liquefaction Process. A. W. Sleeswijk. *Appl. Sci. Res. (A) 7,* 1 (1958) (8 pp.) (From *Appl. Mech. Rev. 12,* 132 (1959) Feb.)

Two criteria for optimum conditions in isenthalpic liquefaction processes are discussed. The first criterion treated is that of maximum yield of liquid per unit of gas compressed. This well-known criterion leads to conditions corresponding to the inversion curve. The second criterion discussed is that of maximum yield per unit of energy expended. This criterion is evaluated and it is shown that it leads not only to greater efficiency but also to working pressures that are considerably lower than those deduced from the first criterion. It should be noted, however, that often in engineering practice neither of the two criteria is applicable because of technical or economical limitations set to the working pressure.

From author's summary

Nitrogen Oxides

Design Data for Oxides of Nitrogen. E. D. Ermenc. *Chem. Eng. 66,* 139 (1959) Feb. 23 (4 pp.)

Nitrogen compounds are assuming greater importance in the chemical industry, and in almost every case the oxides of nitrogen—NO, NO_2, N_2O_4—are the bases of operations. Fields of use include: fuming nitric acid in rocketry, nitration of organic materials and industries such as fertilizers and explosives. Recent appearance of nitrogen compounds on the nonchemical scene is in polluted air, where nitrogen oxides are suspected of contributing to the problem. Therefore, engineers and others are evidencing considerable interest in oxides of nitrogen, their reactions, equilibrium conditions they attain and their chemical and physical properties. Data presented simplify many of the calculations which involved equilibrium relationships and can become quite complicated.

Oil Gas

City Gas Production by Catalytic Gasification of Petroleum Products with the Aid of Fine-Grained Heat Carriers in the Continuous Lurgi-Ruhrgas Process. W. Wustrow and O. Madrich. *Erdol u. Kohle 12,* 9 (1959) Jan. (9 pp. German text.)

Process using fine-grained powder catalyst corresponding to earlier reported coarse-grain process is described. Laboratory and pilot plant results on light-to-heavy factions are given to show effects of temperature and steam ratio. Yields and product and heat balances are given. Gas of controllable calorific value and density is obtained by control of temperature and steam.

Petrochemicals

Chemicals from Hydrocarbons by Vapor Phase Oxidation. J. H. Jones and M. R. Fenske, *Ind. Eng. Chem. 51,* 262 (1959) Mar. (5 pp.)

Variety of hydrocarbons have been successfully converted to useful chemicals by oxidation in the vapor phase and noncatalytically in a new type of reactor. Chemicals produced consist of epoxides (five-, four- and three-membered rings), aldehydes, ketones and olefins. Reactor consists simply of a continuous cycling system in which fine inert solids constantly rain down through the reaction zone. Rain of solids gives uniform temperature control by removing the reaction heat from the homogeneous gas phase reaction, thereby preventing combustion reactions. Proportion of solids needed to achieve desired control is low enough that surface effects are not a factor, and the reaction takes place in what is essentially an open tube.

Complete Byproducts Processing. H. S. Burk and I. E. Thibodeaux. *Oil Gas J. 57,* 91 (1959) Mar. 2 (3 pp.)

Petroleum Chemicals, Inc.-Calcasieu Chemical Corp. petrochemical plant complex at Lake Charles, La., is designed for full processing of refinery byproduct streams. Petroleum Chemicals, Inc., has undertaken an expanded research program under a development department consisting of research, project analysis and market-research divisions. Butadiene plant receives a B-B stream as feed from adjacent refinery. This is supplemented by a C_4's stream coming from the ethylene plant. Ammonia feed plant consists of hydroformer gas from the same refinery, platformer gas from another oil company and dehydro absorber gas from the butadiene plant which is a supplementary or trimmer feed. Ethylene plant feed consists primarily of refinery byproduct gas—a stream rich in ethane and ethylene from the refinery and another stream from the other company. This is supplemented by the ethane-ethylene-and-heavier stream from the ammonia plant LTSU. Ethylene plant is designed to make high purity ethylene from these three vapor feed streams and a (future) liquid propane feed.

Ethylene Oxide Plant Incorporates Catalytic Oxidation Unit, Stream Analyzers for Safety. C. G. Kevil and R. H. Lyles. *Oil Gas J. 57,* 104 (1959) Mar. 2 (3 pp.)

Ethylene oxide plant, at design rate, uses as feed stock some 64,500,000 lb/year of the low purity (98.5%) ethylene from the PCI ethylene plant. Process used is that of Shell Development Co. which carries out direct catalytic oxidation of ethylene with oxygen in fixed-bed reactors. The CCC plant consumes about 115,000,000/year of oxygen at 95%

or better purity. Ethylene glycol is made by thermal hydration of ethylene oxide.

High-Pressure Syntheses of Acetic and Propionic Acids from Alcohols and Carbon Monoxide in Presence of Nickel, Cobalt and Iron Catalysts. S. K. Bhattacharyya and S. Sourirajan. *J. Appl. Chem. 9,* 126 (1959) Feb. (8 pp.)

Optimum yields of acids and esters are obtained with a nickel iodide catalyst supported on an equal weight of silica at about 230° and 3000 psi pressure, the residence time being about 2 hours. Presence of about 5% of water in the alcohol is advantageous and increased yields of acid and ester are obtained when the bomb is cooled to about 60° before release of gaseous pressure. Catalyst is reactivated after one use by addition of 0.5 ml of water per 10 g of catalyst. Decomposition of alcohols and acids to gaseous productions (CO, H_2 and saturated lower paraffins) is discussed.

From Oil to Chemicals. C. E. Morrell. *Ind. Eng. Chem. 51,* 247 (1959) Mar.

Petrochemicals industry is exerting a profound impact on basic chemical technology. One of the most important conversion processes is cracking, the backbone of hydrocarbon intermediate production. Removal of hydrogen from hydrocarbons at high temperatures and in the presence of catalysts is also important. Catalytic reforming, polymerization and oxidation also are widely used.

World's Largest Peroxide Fuel Plant. *World Petrol. 30,* 51 (1959) Feb. (3 pp.)

Laporte Chemicals Ltd. recently opened a £2.5 million chemical plant at its Baronet Works, Warrington, to provide high-test peroxide fuel for rocket motors and guided weapons. Plant will help Laporte to double its output of this important fuel, now in increasing demand for propulsion purposes, being used by Laporte for the manufacture of polymerizing agents used in the manufacture of plastics. Process developed by Laporte is based on the use of 2-ethyl anthraquinone, with the hydrogen made by cracking butane. The carbon dioxide, removed by scrubbing with monoethanolamine, is used as required with a purge gas in the autoxidation process. Hydrogen is passed over a catalyst, when the carbon monoxide content is further reduced with formation of methane, and then compressed for use in the process.

Propylene

High Purity Propylene—A New Problem. J. A. Sherred and J. R. Fair. *Ind. Eng. Chem. 51,* 249 (1959) Mar. (4 pp.)

Propylene is a byproduct in refinery operations or a coproduct in ethylene manufacture. It usually is in admixture with propane and as such suitable for a number of refinery and chemical plant uses. Article is concerned with newer chemical uses for high-purity (99 + %) propylene and technical problems associated with the upgrading operation. Propylene supply and demand, separating methods and purification economics are considered. Adequate supplies of propylene are available for chemical use, and purification by distillation is most practical. Balanced against alternative uses in gasoline manufacture, high-purity propylene can be expected to cost about 0.5 cent/pound less than 95% ethylene.

Reformed Gas

Endothermic Catalytic Cracking of Natural Gas. G. H. Hellendoorn, J. H. Baars and E. deJonge. *Rivista dei Combustibili 12,* 836 (1958) Nov. (11 pp. Italian text.)

Report of a series of industrial scale tests conducted at the Hilversum Gas Works on catalytic endothermal cracking of natural gas. Results of the process, which features a catalyst heating cycle by combustion of natural gas in air and a cycle of natural gas conversion with steam, throw particular light on the importance of the following parameters: Natural gas/steam ratio, steam superheating temperature, composition, temperature and dimensions of catalyst, reagent mixture flow velocity. These results are collected in tables and graphs.

The "MS" Process. *Gas World 149,* 288 (1959) Feb. 7 (7 pp.)

Woodall-Duckham Construction Co., Ltd. (England), have acquired a licence to exploit a new process for the reforming of refinery and liquid petroleum gases and light distillate to produce a town gas possessing completely interchangeable characteristics. In its essentials, plant comprises a single shell generator which carries the catalyst bed, a water seal (wash box) and a direct washer scrubber. Complete cycle is divided into four phases: Heating, steam purging, gas making and steam purging.

Sulfur Removal

Direct Oxygen Regeneration of Spent Petroleum Caustics. W. R. Lucas. *Ind. Eng. Chem. 51,* 84A (1959) Feb. (2 pp.)

Process for direct oxygen regeneration of spent refinery caustics has been developed as a comprehensive solution to these difficulties and in anticipation of future legislation on stream and air pollution. Process has been adapted to the regeneration of various caustic mixtures and the removal of sulfides and mercaptans from waste waters and crude

cresylic acids. It is potentially adaptable to a wide variety of industrial applications.

Water

Treatment of Refinery-Waste Waters with Activated Sludge. P. W. Sherwood. *Erdol u. Kohle 11,* 868 (1958) Dec. (5 pp.)

Removal of toxic materials, such as phenolic compounds, from waste liquors of refineries is reviewed from the standpoint of recent American practice. Extraction and oxidation principles are described, together with the use of regular dilution by domestic sewage or of development of "acclimatized" concentrated sewage sludges. Operating features of five different activation processes are outlined and industrial-scale results are discussed.

Acetylene

Acetylene and Recovery Process. R. W. Rotzler, J. P. Hickman and W. H. Collier (assigned to Monsanto Chemical Co.) U. S. 2,868,327 (1958) Jan. 13.

Acetylene is recovered from mixtures of gaseous hydrocarbon cracking products by scrubbing with an organic solvent, then subjecting the rich solvent successively in separate stages to reduced pressures to desorb the acetylene, removing the acetylene by a steam ejector from each stage to a separate condenser and reinjecting the separated gas into the stage preceding, so as to concentrate acetylene into first stage.

Gasification

Gasification Process. H. N. Woebcke (assigned to Hydrocarbon Research, Inc.) U. S. 2,868,631 (1959) Jan. 13.

Finely divided carbonaceous solids in a water slurry are gasified by a stepwise process which claims: First, predrying the slurry feed by injecting it into a topmost zone fluidized at 300°F by outgoing gas; second, passing dried solids to a lower fluidized zone to be preheated by gasification products; third, passing hot solids to primary gasification zone, where major fluidized reaction at 1800°-2500°F with oxygen and steam occurs; fourth, passing solids down through a secondary gasification zone where remaining carbon is gasified with oxygen and steam, and finally the solid residue is cooled with a minor fluidizing blast of oxygen-steam. Pressures of 250-800 psig, adjustable oxygen-steam ratios and 500°F final cooling temperatures may be used.

Oil Gas

Method of the Catalytic Conversion of Hydrocarbons. C. G. Milbourne (assigned to United Gas Improvement Co.) U. S. 2,868,632 (1959) Jan. 13.

Improved cyclic process is claimed for reforming hydrocarbons into a combustible gas by first preheating the oil to at least cracking temperature and passing oil vapor and steam over refractory packings which are coated with metallic nickel.

Ore Reduction

Method of Converting Hematite to Magnetite. P. E. Cavanagh (assigned to Ontario Research Foundation). U.S. 2,870,003 (1959) Jan. 20.

Hematite ore is reduced to magnetite by an improved process which comprises trickling -150 mesh ore downward into a gas or coal flame burning with controlled low oxygen supply to yield high carbon monoxide combustion gas. At 1800-2000°F, ore is reduced to magnetite, separated by settling and by magnetic treatment.

8. GAS DISTRIBUTION

Leakage

Leakage Control and Corrosion Prevention Program. T. E. Adams. *Gas 35,* 72 (1959) Mar. (3 pp.)

Management is vitally interested in problem of leakage because of its effect upon earnings. Leakage and corrosion of the underground plant are directly related. Because most gas company employees have to be sold on cathodic protection, Consolidated Gas Utilities Corp., Oklahoma City, conducts schools for managers and operating personnel in each division. Article includes specimen forms used for transmission line surveys and distribution surveys and anode installations.

Modern Methods of Leakage Detection. E. R. Fitch. *Gas World 149,* 298 (1959) Feb. 7 (6 pp.)

Description of modern instrument for detection of gas leakages which operates on the principle of heat developed by combustion of inflammable portion of the sampled atmosphere as it passes over a heated catalytic filament, with the resultant unbalance of the electrical circuit of the instrument. Advantages of this instrument over customary leakage indicator are shown and application to test the soundness of a distribution system is discussed. Formation of a Leakage Survey Team in the Lincolnshire Division of the East Midlands Gas Board (England) is described and details of the build-up of this team and equipment are given. It has been shown that not only is a detailed survey of these distribution systems technically possible, but also that such a survey is economically sound.

Metering

Is Automatic Meter Reading on the Way? W. Nickel. *Gas Age 123,* 19 (1959) Feb. 19 (4 pp.)

Recent patent grant covers method of automatic meter reading which can be made available in any home having a telephone, with data transported automatically to computing and billing equipment. Claimed to be easily adaptable to present meter equipment, device is designed to give 300-360 meter readings an hour, complete automation and no conflict with normal customer telephone service.

Odorization

The Theory and Practice of Gas Odorization. *Gas Age 123,* 27 (1959) Feb. 10 (9 pp.)

Adaptation of the Odorization Manual published recently by Natural Gas Odorizing, Inc., Houston, Tex. Article serves as guide for those gasmen not too well versed in details of practice and as a refresher course for those more conversant with the subject. Topics covered include principles of gas odorization, soil penetration, installation and maintenance of odorizing equipment, determining odorization efficiency, and specifications.

Piping

Plastic Pipe Looks to Biggest Year. D. Wright. *Gas 35,* 75 (1959) Mar. (3 pp.)

Survey indicates that plastic pipe will have its biggest year yet in 1959. This year 44 distribution companies have indicated they will install 1.4 million ft of various types of plastic pipe for mains and services. This figure nearly doubles the 728,000 ft 30 companies reported they would use a year ago.

Service Renewal by Plastics Insertion. J. L. Higday. *Gas 35,* 83 (1959) Mar. (4 pp.)

Program of renewing old services by inserting plastic pipe has been economic and successful. Future corrosion potential has been substantially reduced. It has proved to be an invaluable aid to public relations as pipe can be inserted with a minimum of labor and of damage to customers' lawns and other property. Value of plastics insertion is priceless in this respect. Greatest initial savings offered by plastics pipe is through its use for service replacement by insertion.

Use of Plastic Pipe in a Rural Distribution System. J. V. King. *Gas 35,* 78 (1959) Mar. (5 pp.)

Western Gas Service Co., Ysleta, Texas, serves 40,000 customers in Texas, Oklahoma and New Mexico. Company has been actively building up its summer sales through promotion of natural gas for irrigation pumping in the irrigated farming area it serves. There are 300 irrigation wells in the Deming area of New Mexico. This area spreads over 180 square miles with 21,000 acres in cultivation. Article discusses application of plastics pipe in this area for low-cost gas service.

Odorization

Fuel Gas Composition Containing Odorant. A. D. Nevers and E. D. Fettes (assigned to Pennsalt Chemicals Corp. and to Thiokol Chemical Corp.) U.S. 2,869,994 (1959) Jan. 20.

Dimethyl para-thioxane and other alkyls up to 3 carbon atoms are claimed as a stable odorant of high impact value for fuel gases.

9. GAS FUEL UTILIZATION AND APPLIANCES

Air Conditioning

Gas Dehumidifies Army Storage Cave. R. Smith. *Gas 35,* 71 (1959) Feb. (4 pp.)

In a 60-acre limestone cave at Atchison, Kan., natural gas utilization is enabling use of the cave for storage of machine tools. Against the fact that delicate precision machinery is extremely vulnerable to rust and deterioration is arrayed the fact that in its natural state the cave's atmosphere is one of high humidity. This shortcoming has been overcome by natural gas fueled dehumidification machines that remove 7000 gal of water every day from the 18 million CF of air in the cave.

Air Pollution

Air Pollution Control Demands Engineering Analysis, Design. *Heating, Piping & Air Conditioning 31,* 139 (1959) Feb. (16 pp.)

Air pollution means different things to different people living under different conditions. When standing downwind of a smoking stack, problem is one of soiling, poor visibility and odor. In Los Angeles on a smoggy day, eye irritations and blurred visibility are the problem. Many factors acting simultaneously determine whether the dusts, fumes, gases and vapors emitted to the atmosphere become a pollution problem from the standpoint of annoyance or effect on individual health or both. Extent of problem in each area and potential for growth of the problem determine the efficiency of equipment that must be used to clean effluents of industrial processes. Specific effluents involved also must be considered. Although engineer may not be called upon to conduct an air pollution survey of an area, some knowledge of the effects of topography, meteorology, legal requirements, neighborhood requirements and types of contaminants involved is

needed. Knowledge is necessary to properly assess air pollution surveys when they are available, and to establish the degree of control required in areas that have not been surveyed and where there are no legal requirements.

Air Pollution Effects of Incinerator Firing Practices and Combustion Air Distribution. A. H. Rose, Jr., R. L. Stenburg, M. Corn, R. R. Horsley, D. R. Allen and P. W. Kolp. *J. Air Pollution Control Assoc. 8,* 297 (1959) Feb. (13 pp.)

To more rapidly develop incinerator design standards and criteria for minimizing discharge of atmospheric pollutants, U.S. Bureau of Mines is studying the single chamber incinerator at the same time that the Public Health Service is studying the multiple chamber type. Article covers first phase of the multiple chamber incinerator study which was conducted to obtain, on a test incinerator of fixed dimensions, information on the effect of varying 1) amount and distribution of combustion air; 2) burning rate as measured by the amount of fuel charged per hour; 3) amount of fuel per charge and 4) the interval between stoking the burning fuel bed.

Auto Exhaust: Composition and Photolysis Products. E. R. Stephens, P. L. Hanst, R. C. Doerr and W. E. Scott. *J. Air Pollution Control Assoc. 8,* 333 (1959) Feb. (3 pp.)

Discussion of some simple analyses of engine exhaust using a long-path infrared absorption cell. Some of these samples, diluted with oxygen, were irradiated with a mercury vapor lamp which simulates sunlight. Products of the photochemical reactions were determined and also are discussed. This was done to provide information on products to be expected when exhaust is vented to the atmosphere and allowed to react under influence of sunlight.

Eye Irritation from Irradiated Automobile Exhaust. (Effect of Irradiation Intensity; Half-Life Studies.) E. A. Schuck and L. H. Rogers. *J. Air Pollution Control Assoc. 8,* 310 (1959) Feb. (4 pp.)

Both the reported degree of eye irritation and values of the oxidant and nitrogen dioxide in the exhaust-air mixtures were found to vary directly with the irradiation intensity. Half-life of the eye irritant was found to be about 24 hours, as measured by a panel of 10 human subjects. Decay rates of the oxidant and nitrogen dioxide under static state conditions were shown to be direct functions of time, as measured by recording instruments. During the static state experiments, decay rates indicated a half-life of less than one hour for oxidant and less than 0.5 hour for nitrogen dioxide. Oxidant decay was independent of additional irradiation; the nitrogen dioxide decay was increased by additional irradiation.

Burners

Burner Design Gives More Uniform Heat. H. W. Morgan and R. J. Reed. *Petrol. Refiner 38,* 135 (1959) Feb. (4 pp.)

Flat flame type of burner is ideally suited to direct-fired process heaters because the new principle of directing the flame along the wall, instead of forward, provides such uniform heat transfer. Some advantages of this design include better process control, improved coil and refractory life, more compact heater installations and fewer burners per coil. Results of tests with this type of burner are discussed and suggestions for controlling their operation included.

Combustion

Troubleshooting Chimneys, Fans and Drafts. V. J. Lawton. *Gas Heat and Comfort Cooling 10,* 36 (1959) Feb. (2 pp.)

Correction of trouble is no easy matter. In some cases, the boiler room may be effectively sealed off from the rest of the premises and provided with an adequate supply of air. In the majority of cases, the quickest and most satisfactory remedy is the installation of a suitable flue exhaust fan, wired so as to operate whenever the gas burner is in operation. It is important to note that an adequate supply of air for combustion purposes should be introduced into every furnace room, whether the chimney has gravity draft or mechanical draft.

Flame Research

Confined Jets and Recirculation Phenomena with Cold Air. R. Curtet. *Combustion and Flame 2,* 383 (1958) Dec. (29 pp.)

Approximate theory of confined jets established by A. Craya and R. Curtet is developed, allowance for wall effect being made when studying the mixing of a jet with a surrounding stream enclosed in a duct. Two-dimensional and axisymmetric conditions are considered. Experimental results are given; these show two distinct regimes can be identified, and the creation of recirculation is discussed. Agreement between theory and practice is examined, and application of this work to a test furnace at IJmuiden noted.

On the Decomposition Flame of Liquid Ozone-Oxygen Mixtures in a Tube. R. Sandri. *Combustion and Flame 2,* 348 (1958) Dec. (5 pp.)

Theory of flame propagation previously developed by the author is applied to a decomposition flame burning above a liquid ozone-oxygen mixture in a tube cooled with liquid oxygen at the outside. Neglecting heat losses to the wall, heat radiation and heat conduction along the glass tube, flame velocities

are computed for pressures of 1, 2 and 10 atoms. for mixtures containing 50, 75 and 100% ozone. Results obtained for atmospheric pressure are in reasonably good agreement with the available experimental result.

Energy Release Rates in Flames Stabilized by Cyclonic Flow. W. F. Kenney and L. F. Albright. *Ind. Eng. Chem. 51,* 227 (1959) Feb. (2 pp.)

Rates of energy release in flames stabilized by cyclonic flow were measured in ducts 2 inches in diameter and 9.5-28.5 inches long. Variables studied were flow rates, air-fuel (propane) ratio, combustion volume and degree of cyclonic flow. Combustion efficiency varied significantly with air-fuel ratio, was a maximum at approximately the stoichiometric ratio, and increased with longer ducts and higher degree of cyclonic flow. Maximum rate of energy release measured was 13,400,000 Btu/hr/CF at atmospheric pressure, but combustion was not complete for this flame; with complete combustion, rates were about 12,000,000 Btu.

Flow Field of a Flame in a Channel. M. H. Uberoi. *Phys. of Fluids 2,* 72 (1959) Jan.-Feb. (7 pp.)

Stationary flame is stabilized in a two-dimensional channel in such a way that it closely corresponds to the case of a flame propagating in a channel. Entire flow field of unburned and burned gases is mapped by taking stroboscopic photographs of small particles suspended in the combustible gases. Asymptotic flow field of the burned gases is analyzed in terms of flow conditions at the flame. Possibility of obtaining an analytic flow field on the basis of constant flame speed is examined. It appears that no solution exists unless the channel walls in the region of burned gases are displaced inward. This investigation, together with the previous work on the flow field of a Bunsen flame, leads to some general remarks about the structure and stability of laminar flames. Various predictions are in agreement with experiments. In particular, the convex flames are possible and concave ones impossible within the framework of the theory based on constant flame speed.

Experimental Study of a Reversed Jet Flameholder. G. A. Agoston, A. W. Noon and T. D. Witherly. *Combustion and Flame 2,* 333 (1958) Dec. (15 pp.)

Experiments and analyses were performed to contribute to a basic understanding of the holding of flame in a stream of a combustible gas mixture by a small gas jet directed upstream. The main stream, a mixture of natural gas and air, entered a cylindrical transparent test section at uniform velocity. A flameholding jet of air was directed counter to the stream along the axis of the test section. Observations of the flow field and flame behavior were made by means of time-exposure photographs, high-speed motion pictures and spark shadowgraphs. A pilot flame was delineated, and its significant time-average dimensions were noted as a function of jet and mainstream velocities.

Luminosity and Soot Formation in Hydrocarbon Flames. D. W. Gill. *BCURA Monthly Bull. 22,* 487 (1958) Nov./Dec. (20 pp.)

In a review of 113 articles, author presents theories of carbon particle formation in flames and indicates supporting evidence from laboratory data. Polymerization of acetylene by dehydrogenation and formation of vapor or solid carbon are favored processes. Utilization and practical control of combustion to yield luminous flames are discussed.

Spectroscopic Studies on Temperature Gradients in Flames. R. H. Tourin. *Combustion and Flame 2,* 353 (1958) Dec. (12 pp.)

Intensity distribution in the infrared emission spectrum of a flame depends to a large extent on self-absorption within the flame. This self-adsorption depends not only on the magnitude of the spectral absorption coefficients, but also on the temperature gradient along the optical path through the flame. Calculations were carried out to obtain estimates of the radiation contributions to the 4.3 micron emission band of carbon dioxide from zones of a flame at various temperatures, for typical temperature distributions encountered in practice. Temperature dependence of rotational energy distribution was accounted for in each vibrational transition. Calculated spectral contours were compared with measured spectra obtained with a special burner in which known temperature gradients could be set up at will. Results indicate that this technique may prove a useful tool in analyzing temperature distributions within a flame.

Furnaces

Tube by Tube Design of Light Hydrocarbon Cracking Furnaces Using a Digital Computer. A. J. Andrews and L. W. Pollock. *Ind. Eng. Chem. 51,* 125 (1959) Feb. (4 pp.)

Pyrolysis of light hydrocarbons is of growing commercial importance for the production of olefins which are used in the manufacture of petrochemicals. Program was developed for the design of tube furnaces for thermal cracking using a medium-sized digital computer. By machine computation, a furnace design may be obtained with speed and precision of calculation for butane, propane or ethane feedstock. Composition, temperature, pressure and enthalpy of the gas and skin temperature of the tube are determined for each tube. For a given furnace

design, effect of such variables as type of feed, heat flux, pressure, temperature, steam rate and feed rate on furnace operation and olefin yield may be predicted. Calculated results are compared with commercial furnace data.

Heat Treating

Continuous Hardening and Tempering of Heavy Loads of Cast Iron Parts. R. B. Hammond. *Ind. Heating 26,* 262 (1959) Feb. (4 pp.)

Hardening, quenching and drawing of cast iron parts is done continuously in a new furnace installation rated at 4000 lb/hr. It is located in one of the leading automotive parts manufacturing plants. Conveyors integrating the three units of the facility are specially designed to handle heavy loads.

Industrial Heating

New Kuwait Brick Plant Uses Natural Gas. J. Grindrod. *Ind. Gas 37,* (Amer.) 8 (1959) Feb.

New sand-lime brickworks makes use of abundant supplies of natural gas from the oilfields. Plant was designed and detailed analytical work carried out by George Wimpey & Co. Ltd. Plant which was erected by the Kuwait Public Works Department has been located at the northern boundary of the sand deposits which will be used for brickmaking, these deposits lying fairly close to the development area and alongside the road to the oilfields.

Vacuum Die Casting of Aluminum and Zinc Alloys. J. P. Moehling, Jr. *Ind. Gas 37,* (Amer.) 13 (1959) Feb. (4 pp.)

It has long been contended that so-called voids or microporosities in die castings are result of air being trapped within the dies following the almost instantaneous rate of hot metal injection at high pressures, followed by a rapid cooling cycle. Density and gain in physical properties of castings produced by vacuum process offer some logical proof of this contention. In the Vacucast system a complete enclosure or hood is built around the platen area of the machine. Mating surfaces of these hoods are equipped with flexible vacuum seal which allows the hood to be sealed before the dies are fully closed.

Inert Gas

High Purity Nitrogen (99.99%) by New Process. *Ind. Heating 26,* 278 (1959) Feb. (3 pp.)

New nitrogen generator packaged unit completely piped and wired for production of nitrogen atmosphere by combusting a mixture of air and natural gas, or any manufactured gas such as butane, propane, watergas or coke oven gas, is available. Atmosphere produced is CO_2 free, dry combusted gas which may be varied from rich to lean ratios of the air-gas mixture of the exothermic generator. Generator can also be operated on the oxidizing side to eliminate all combustibles, if desired.

LPG

Line Transmission of LP-Gas—1. C. C. Turner. *LP-Gas 19,* 35 (1959) Feb. (12 pp.); **Line Transmission of LP-Gas—2.** *Ibid., 36* (1959) Mar. (4 pp.)

Modern appliances with their small pilots and delicate temperature controls are sensitive to pressure drops of a fraction of an inch of water column. Present efficiencies and speed records become ineffective if proper pressure at the appliances is not maintained. Quite often it is necessary to do a complete repiping job when a modern appliance is sold to an old customer. Service problem where pressure drop is involved is not corrected by simply increasing pressure at the regulator. It is pressure drop, not pressure, that causes pilots and temperature controls to fail. It is possible to operate a modern LPG appliance satisfactorily at any pressure within reason provided gas pressure at the appliance is constant. Two-part article includes eight charts showing capacities of pipes and copper tubing for propane gas with inlet of 5 or 10 lbs and pressure drops of ½ lb to 9½ lb or ½ lb to 4½ lb at delivery end.

Understanding LP-Gas Carburetion. D. Reber. *LP-Gas 19,* 43 (1959) Mar. (2 pp.)

Ever-increasing number of LPG dealers throughout the U. S. are beginning to realize potentials the carburetion market has to offer. In response to a series of inquiries, a series of articles will be published to provide comprehensive information on the basic carburetion facts. Article serves as introduction and outline of series.

Pilot Lights

Application of Existing Flame-Protective Equipment to Oil and Gas Burners. W. F. Lange and J. Dunn. ASME Paper No. 58-A-279. (New York: ASME, 1958.)

Flame-protective devices presently are used as burner safeguards by scanning and proving pilot-igniter flame and main-burner flame. Much written on the low-capacity, single and dual-burner application is not discussed except to state that satisfactory performance in this category is a matter of record. Discussion is limited to the use of flame-protective equipment on multi-burner large central-station and industrial boiler installations. It attempts to treat matter from both an application and an operating point of view. Discussion does not include design and circuitry of the devices themselves and coverage is

limited to the photoconductive type of units which are in most general use.

Compatibility of Flame-Failure Equipment with Boiler Controls. R. Forney. ASME Paper No. 58-A-256. (New York: ASME, 1958.)

Thesis of paper is simple. If the manufacture of flame-failure equipment, design engineer, construction superintendent, plant operator and maintenance foreman each does his job properly, there certainly will be compatibility of flame-failure equipment with the boiler controls. Each member of this team is dependent on the other and each must carry his share of the load. Failure of one member spells ultimate dissatisfaction with the flame-failure device. In this area of power-plant operation, a mistake by one member is very difficult to compensate for by the other members.

Need for the Requirements of Flame-Protection Equipment for Gas—Oil—Pulverized Coal. J. B. Smith. ASME Paper No. 58-A-227. (New York: ASME, 1958.)

Larger boilers and correspondingly more severe boiler-furnace fuel explosions, manual lighting-off by remote control, and automatic lighting-off are three current trends in large boiler installations, such as the public utility type, which increase need for flame-failure protection equipment. Two criteria for direct and continuous measurement of the fuel-explosion hazard, utilizing instruments available today, are 1) pressure or absence of normal flames and 2) concentration of combustibles and oxygen in the boiler-furnace, flue gas. The ability of the presently available instruments to furnish the protection needed and some of the special problems common to large boilers of the public-utility type are discussed. It is concluded that flame-failure protection consisting of a combination of the flame-sensing and combustibles-oxygen gas-analyzer instruments should be recommended for such boilers.

Refrigeration

How to Operate and Maintain Centrifugal Refrigeration Machines. P. Ellard. *Petrol. Refiner 38,* 123 (1959) Feb. (8 pp.)

Centrifugal compressors are the heart of modern vapor compression refrigeration units. Range in which this type of unit is commercially practical extends all the way from below 100 tons to above 3500 tons. Top figure is not a maximum capacity, but represents the largest machine required commercially to date. Current trend is toward higher capacities using higher pressure refrigerants. More dramatic advances are heralded for this type of equipment by a tiny compressor-turbine, the size of a football, which has a capacity of 15 tons and which weighs only 150 pounds. Article includes guide to proper maintenance of this type of equipment and a trouble-shooting check list.

How to Select Refrigeration Equipment. J. T. Robertson. *Petrol. Refiner 38,* 115 (1959) Feb. (8 pp.)

No stock refrigeration machine, system or refrigerant will satisfy the requirements of all cooling jobs. Manufacturers of refrigeration equipment can provide designers with cost figures, utility requirements, space dimensions and any other recommendations for developing the best refrigeration system for immediate and long-range plans. As use of refrigeration expands, it becomes increasingly more important to study thoroughly all aspects of any refrigeration plant to see that it will adequately satisfy cooling specifications, have a just first cost, is economical to operate and will not cause excessive maintenance expense.

Which Refrigeration Cycle Is Best? R. L. Huff. *Petrol. Refiner 38,* 111 (1959) Feb. (4 pp.)

Article compares vapor-compression and ammonia absorption refrigeration systems on the basis of typical investment and operating costs in the range of —20°F to + 50°F. Author tries to point out need for a complete evaluation of refrigerant condensing temperature limits, proper selection of a refrigerant and most efficient system to achieve the desired refrigeration load. Generally, stock item equipment does not take all of these facts into consideration.

Space Heaters

Gas Space Heaters, Inside and Out. F. Lowe. Part I. **The Workhorse of the Industry.** *Gas Heat and Comfort Cooling 9,* 16 (1958) Dec. (3 pp.); Part II. **Service and Maintenance.** *Ibid 10,* 34 (1959) Feb. (2 pp.)

Discussion of reasons for existence of selling opportunities for space heaters and their application to various situations is covered in Part I. In second part author points out that servicing problems are limited to combustion troubles. Steps to be taken include setting input at or slightly below rating, proper primary air adjustment, keeping the shutter clear of lint or other obstructions and burner ports clean and free of of encrustation or corrosion.

Space Heating

Heating Britain's Largest Office Block. *Fuel Efficiency 7,* 13 (1959) Feb. (3 pp.)

Heating of large area of offices (total floor area, over 475,000 ft^2) and of the three restaurants and

two public houses and supply of hot water necessary to cloakrooms and domestic purposes are catered for in a modern and well laid out two story boiler house in the basement and subbasement. There are four forced circulation, oil-fired water tube boilers, each capable of an output of 7,000,000 Btu/hr, operating at a pressure of 85 psi and a temperature of 260°F. These are each fitted with four low pressure air type burners arranged for modulating control, the controls being designed to automatically regulate the oil and secondary air supplies to the burners in proportion, in order to maintain a practically constant flow temperature and combustion efficiency. Boilers are controlled by means of a potentiometric controller operating all four boilers by a single thermostat in the common primary flow main.

Higher-Priced LPG Can Be Sold Against Cheaper Fuel Oil. W. W. Clark. *Butane-Propane News 21,* 34 (1959) Mar. (3 pp.)

Gas for space heating probably will cost 10% more than oil, and gas for central heating will cost 20% more than oil. However, this will be partially offset by lower electric bills, no yearly furnace cleaning (this usually runs at least $15), elimination of the $50-$60 investment in a fuel tank and the lower first cost.

Air Pollution

Method of Catalytically Purifying Exhaust Gases and Regenerating the Catalyst Utilized Therein. E. J. Houdry and W. R. Calvert (assigned to Oxy-Catalyst, Inc.) U.S. 2,867,497 (1959) Jan. 6.

Improved catalytic oxidation of combustibles in automobile exhaust gases by particulate metallic catalyst beds is claimed, in which the accumulation of lead deposits from combustion of leaded gasolines is periodically removed by an aqueous dissolving reagent (nitric acid), in a soaking or recirculating contact with the bed, followed by rinsing and then drying of bed by exhaust gases.

Burners

Gas Burner. E. C. Jackson. U.S. 2,867,271. (1959) Jan. 6.

Unit burner structure is claimed, for ready insertion in a furnace wall, and comprising the nozzle, venturi tube with flame baffle and a shut-off control which operates by the heat of the pilot flame.

Gas Burner. H. E. Morrison (assigned to Whirlpool Corp.) U.S. 2,867,272 (1959) Jan. 6.

Simplified burner unit for use in gas clothes dryers is claimed, comprising a horizontal spun-metal tube venturi, with gas nozzle, cylindrical air shutter and curved flame port, said port protected by a hemispherical flame deflector.

Gas Burner Assembly. J. S. Zink (assigned to J. Zink Co.) U.S. 2,869,631 (1959) Jan. 20.

Pilot-type industrial burner is claimed in which a portion of the feed gas is continuously bled forward to pass over the flame ports where it is directed by a curved hood and ignited by usual means.

Gas Burner with Selective Flame Distribution. J. H. Flynn. U.S. 2,869,930 (1959) Jan. 20.

Tubular gas burner with selective distribution of flame over sections of its length is claimed. This comprises the horizontal mixing chamber with continuous lengthwise flame-port slot, with chamber divided into several consecutive compartments and with a smaller fixed axial gas feed tube with outlet ports in its cylindrical wall into the compartments. Lengthwise tube closely fits the fixed feed tube, is rotatable from one end, and has gas ports in its wall to register with ports of the fixed tube, so arranged as to feed gas to a selected burner compartment when turned to a selected angular setting, and is connected to suitable gas supply.

Pressure Gas Burners. P. Bornkessel (assigned to P. Bornkessel). U.S. 2,869,632 (1959) Jan. 20.

Pressure gas burner is claimed, the flame nozzles of which are supplied with high pressure mixture of gas-air by separate feed compartments which also supply low-pressure gas-air mixture through a concentric nozzle tube.

Flame Research

Process for Burning Gaseous Fuels. C. J. Pedersen (assigned to E. I. duPont de Nemours and Co.) U.S. 2,867,516 (1959) Jan. 6.

Reduction of smoking tendencies of a flame of hydrocarbon-oxygen mixed gas is claimed by adding to the combustion mixture 1 part by weight of volatilizable dicyclopentadienyliron per 20-2000 parts of gas fuel.

Heat Treating

Metal Heating. F. O. Hess (assigned to Selas Corp. of America). U.S. 2,867,431 (1959) Jan. 6.

High-temperature billet heating furnace is claimed, in which the billets carried on a refractory car are heated by radiation and convection in an elongated chamber fired by gas burner banks at each end, with the combustion gases exhausting at the middle. Fast surface heating is claimed up to transformation temperature, at billet center, with further heating at decreasing rate at desired forging temperature.

Pilot Lights

Gas Burner Control Means. W. D. Antrim (assigned to Carrier Corp.) U.S. 2,868,278 (1959) Jan. 13.

Control of a main gas burner is claimed by a com-

bination of a constant pilot and a safety pilot which gives thermal response needed to control a safety valve in the main gas line, the constant pilot arranged to provide ignition for the safety pilot. Pilots and valves are located to operate in the combustion space.

10. EQUIPMENT AND INSTRUMENTATION

Automation

Computer Runs Refinery Unit. *Business Week 1540,* 33 (1959) Mar. 7.

Daystrom and Universal Oil Products have developed an electronic system that can operate and control the most complex petroleum processing. Operation of the pilot plant—which includes a fractionating tower—is an important first in the field. Computer is demonstrating that it can "learn" to adjust the process continually to optimum output according to product or economic standards.

The Genealogy of Remote Control. A. L. Hancock. *Gas J. 297,* 225 (1959) Feb. 11 (6 pp.)

In order to control a plant at a distance, two things are necessary: Information as to what is happening at the plant must be conveyed to the distant operator, and orders given by the operator must be conveyed to the plant. Any message sent by electrical means and received by an operator must produce an effect which he detects by one of his five senses. If there is no operator, and the signal has to perform some task itself, there is no difficulty. Very important difference is that at the plant, messages are sent automatically, and received messages have an automatic effect, whereas at the other end of the line, the operator receives indications by eye or ear and sends his orders by hand. This consideration does have some effect upon techniques employed.

Process Control and Automation. T. J. Williams. *Ind. Eng. Chem. 51,* (Chem. Eng. Rev.) 432 (1959) Mar. (5 pp.)

Most dramatic development in the field and the one which will have the greatest effect upon future progress, both in magnitude and direction, is the tremendous effort being exerted by several of the defense electronics development companies and the digital computer manufacturers to sell digital computers as process control elements in chemical plants and petroleum refineries. Universities are actively engaged in upgrading their automatic control and instrumentation courses to include the newer aspects of servomechanisms and process dynamics. Bibliography of 341 items includes references on analog computers and simulation, digital computers in simulation and control, process control loop components, process control applications and process dynamics, instrumentation and control systems and instruction and general articles.

Computers

Analogue Computers in Chemical Engineering. Part 1. General Principles. G. E. Thomas. *Chem. Process Eng. 36,* 343 (1958) Oct. (4 pp.); **Part 2. Applications of a General-purpose Analogue Computer.** D. S. Terrett. *Ibid.,* 442 (1958) Dec. (4 pp.); **Part 3. Chemical Process Design on an Analogue Computer.** *Ibid. 37,* 58 (1959) Feb. (5 pp.).

Various basic units performing standard mathematical functions in a general purpose analog computer are discussed in Part 1. Arrangement of these units by suitable interconnection to solve a wide range of problems in the mathematical and engineering fields are the subject of Part 2. Part 3 describes how a chemical process and its proposed control system were set up for solution by simulation on a computer.

Organizing a Network of Computers. *Tech. News Bull. 43,* 26 (1959) Feb. (3 pp.)

Many large-scale data processing jobs call for much faster computing capabilities than presently available machines can provide. Resulting demand for computer components of higher basic speed has in many respects exceeded the resources of the current component technology. As a consequence, in order to shorten problem-solving times, it became necessary to try to organize these components into more powerful logical combinations for doing the job. One avenue of approach is to connect together several computers into an integrated network so that all of the machines in the network can be made to work together on large-scale tasks. By dividing the total task into different pieces and by having all the different computers in the system work on the different pieces of the task simultaneously, an increase in the speed of the solution can be achieved.

Instruments

Semi-Conductors, Transistors and Isotopes. C. R. Plant. *Gas World 149,* (Coking Sec.) 27 (1959) Feb. 7 (5 pp.)

Article is based on results of wide survey and extends beyond the normal fields of coke oven technology. Applications in coking plant operations are described.

Pilot Plants

Design Considerations for Continuous Pilot Plants at Elevated Pressure. E. L. Clark. *Ind. Eng. Chem. 51,* 61A (1959) Feb. (4 pp.)

Today, vessels, pumps, compressors, valves and

piping materials for pressures up to 25,000 psi are stock manufacturer's items. Data are readily available which permit the experimenter to select designs of components for much higher pressures. However, assembly of these component parts into an operable and safe pilot plant still is a problem which must be faced.

Process Design

Product Design for -300 F. P. E. Loveday. *Product Eng. 30,* 60 (1959) Feb. 2 (3 pp.)

As more products are required for handling supercold gases given by liquefaction, job of design gets harder. Problems include embrittlement, atmospheric moisture, insulation, conduction, shrinkage, lubrication, combustion and asphyxiation hazards and vaporization.

Refrigeration

Extremely Low Temperatures . . . Production and Commercial Uses. O. A. Hansen. *Chem. Eng. 66,* 123 (1959) Feb. 23 (16 pp.)

Refrigeration producing machinery falls generally into three types: change of phase, Joule-Thomson effect and expansion engine. First type provides a maximum of refrigeration per unit of material, but it cannot be used under all conditions. Very low temperatures of cryogenics are used for separation of components, or for extreme retardation of chemical or physical processes. It is in the first of these that most experience has been gained. Principal reason for using the low temperatures of cryogenics is that these temperatures have an effect on materials. But these effects can apply to the apparatus as well as to the material in process. Accordingly, containers and apparatus must be designed with these considerations in mind. Research on physical properties of matter at low temperatures has resulted in discoveries of paramount importance such as 1) confirmation of the third law of thermodynamics; 2) direct evidence of molecular rotation in solids; 3) laws of Curie and Weiss for paramagnetic materials; 4) discovery of ortho and parahydrogen; 5) early confirmation of quantum theory in finding that below -350°F the specific heat of hydrogen falls to that of a monatomic gas; 6) superfluidity and the quantum nature of liquid helium, and 7) superconductivity.

Temperature Measurement

Photometry of the Optical Pyrometer and Its Use Below 800°C. D. R. Lovejoy. *J. Optical Soc. Am. 49,* 249 (1959) Mar. (5 pp.)

Standard deviation of temperature measurements due to uncertainty in photometric matching has been determined for the disappearing filament optical pyrometer, with and without a red filter, for exit pupils of 0.7-mm and 1.4-mm diam and for filament apparent angular widths of 10 min and 7 min. It is shown that the results are in quantitative agreement with the direct measurements of contrast limens reported by Blackwell. With a good commercial pyrometer in which the red filter has been removed it is possible to make measurements with a standard deviation for a single pair of observations of 6°C at 600°C.

Refractory-Metal Thermocouples Containing Rhenium. C. T. Sims, G. B. Gaines and R. I. Jaffee. *Rev. Sci. Instruments 30,* 112 (1959) Feb. (4 pp.)

Thermoelectric force developed by the following junctions up to 2200°C has been measured: Re vs W, Re vs Mo, Re vs W-30Re and Re vs Mo-50Re. Thermoelectric force for W vs W-30Re and Mo vs Mo-50Re has been calculated. The Re vs W junction develops about 15 mv at 1000°C and may be usable up to 2600°C. Re vs Mo develops about 17 mv at 1000°C; the thermoelectric power is low above 1600°C. Outputs of Re vs W-30Re and Re vs Mo-50Re couples are low and change signs at about 1200 and 1800°C, respectively. Calculated outputs of W vs W-30Re and Mo vs Mo-50Re are high; the W vs W-30Re output is nearly linear over a wide range in temperature, and the thermocouple should be useful to about 2600°C. All of these couples must be used in vacuum or in neutral or reducing atmospheres.

Valves

A Fresh Look at Selecting Control Valve Characteristics. J. E. Valstar. *Control Eng. 6,* 103 (1959) Mar. (6 pp.)

Choosing the right valve characteristic is a matter of utmost importance in many processes, especially those needing close, stable control and having small holdup times. Author has organized a set of rules that readily enables control engineer to select best valve characteristic with respect to static and dynamic effects of the disturbing variables. Article traces development of the selection rules—grouped in a table for future reference and use—and concludes by showing how to determine best valve characteristic for four types of recurring process control problems.

Welding

Revise ASA Butt Welding Standards to Simplify Layout, Fabrication of Piping Systems. H. H. George. *Heating, Piping & Air Conditioning 31,* 123 (1959) Feb. (5 pp.)

Changes that should help simplify piping layout and

fabrication are features of the latest revisions of two American Standards: B16.9, covering steel butt welding fittings, and B 16.25, for butt welding ends. Revisions have been approved by the American Standards Association and are published by the ASME as ASA B16.9—1958 and ASA B16.25—1958. Both Standards are sponsored jointly by the Mechanical (Heating, Piping and Air Conditioning) Contractors Association of America, the Manufacturers Standardization Society of the Valve and Fittings Industry, and the ASME. Article discusses highlights briefly.

Conveyors

Pulsating Counter-Flow Feeder. C. C. Shale (assigned to U.S.A.) U.S. 2,867,478 (1959) Jan. 6.

Improved method and apparatus is claimed for introducing controlled amounts of pulverized solids (catalysts, coal) into a pulsating gas stream. Powder from the storage hopper is fed to a "constant-height feed" hopper from which a vertical feed pipe with calibrated orifice enters the gas chamber. Pressure wave of pulsating gas vents itself up the latter feed pipe to pass above the feed hopper bed. Then this controlled excess of pressure forces some powder out of the orifice into the gas stream when the minimum of the pulsation cycle occurs.

Fractionation

Continuous Gas Absorption Process and Apparatus. R. A. Findlay (assigned to Phillips Petrol. Co.) U.S. 2,869,672 (1959) Jan. 20.

Closely boiling liquid mixtures are separated continuously into two fractions of high purity by a gas chromatography method. Feed is passed into a column of (downward) moving spheres which are coated with a film of non-volatile selective solvent. An eluent gas is passed countercurrently to the spheres to remove the more volatile fraction from the column top. Less volatile material remaining dissolved in the solvent coating is carried downward with the moving bed of spheres into a lower stripping zone where the fraction may be removed by steaming and the coated spheres returned by airlift or elevator to the top of the apparatus.

11. MATERIALS OF CONSTRUCTION, AND CORROSION

Cathodic Protection

Designing for Minimum Cathodic Protection Interference. C. A. Erickson. *Gas 35,* 70 (1959) Mar. (2 pp.)

One of the most aggravating and costly steps in protection of a pipeline against corrosion is elimination of cathodic protection interference on other underground structures. Anything that can be done in the design stage to minimize these problems is time and money well spent.

Coatings

Automatic Yards Speeds Weight-Coating. *Pipe Line Ind. 10,* 44 (1959) Feb. (3 pp.)

In developing a highly automatic asphalt-mastic weight coating plant, Southern Natural Gas Company and Brown & Root, Inc., have made important advances in increasing production and getting better controlled protective-weight coating for submarine pipelines. New methods include wash with light oil for primer, thin muslin outer wrap and whitewash to produce tough and heavy asphalt-mastic coating.

Coating Steel Pipe for Gas Service. J. S. Dorsey and C. E. Lee. *Gas 35,* 129 (1959) Mar. (6 pp.)

Prevention of corrosion on steel pipelines used in the gas industry is usually accomplished by coating the pipe with an insulating material, by the use of cathodic protection or by a combination of both methods. Article discusses standard coatings used at Southern California Gas Co., Los Angeles, and shows sample specifications used for filled asphalt, yard-wrapped pipe and the data sheet used in connection with repair of an underground corrosion leak.

Pipe-Wrapping Materials for Corrosion Protection. J. G. Parry and J. R. James. *Corrosion Tech. 6,* 35 (1959) Feb. (3 pp.)

In the early days of pipe protection, it was thought that any coating reinforced with any type of wrapping could not fail to extend the life of a buried pipeline system. Today, as a result of experience accumulated by many users in different parts of the world, we know that only the careful selection of both pipe coatings and reinforcing inner and outer wraps can be relied on to protect a buried pipeline system effectively. Article considers functions of a pipeline coating, and materials and coating systems which best carry out these functions.

Polyvinyl Chloride Tapes for Pipe Protection. K. S. Chitty. *Corrosion Tech. 6,* 39 (1959) Feb. (3 pp.)

It would be easy to make the general statement that the only major factor an engineer need consider when selecting a pipe protection material is that it should resist corrosion. Certainly he must be concerned with electrolytic and galvanic attack, abrasion, chemical action and the effect of weather. This, however, is only part of the story. Article reviews the properties of polyvinyl chloride tapes and the very

real part which they, and in particular Scotchrap PVC tapes, are playing in the prevention of pipeline deterioration.

Corrosion

Corrosivity of Soil. N. D. Tomashov and Y. N. Mikhailovsky. *Corrosion 15,* 77t (1959) Feb. (6 pp.)

Consideration is given to merits and disadvantages of methods used to determine corrosive activity of soils. Data obtained by all methods considered failed to give comprehensive characteristics of the corrosive properties of soils. Detailed discussion is given of the peculiarities of formation and functioning of macro- and micro-corrosion elements in corrosion of soils. Corrosion elements of differential aeration on the metal surface in soil resulted from: Non-uniform oxygen diffusion of neighboring portions of the soil, local fusion on the end of the structure and different depth of separate parts of the structure. Theoretical foundations of a suggested method for the appraisal of the corrosiveness of soils are discussed. Description is given of an apparatus designed to measure corrosion characteristics of soil under field conditions. Good results were obtained in field tests conducted with the instrument. Data are given to show the correlation between instrument readings and corrosion rates in various types of soils.

An Electrochemical Study of Aluminum on Aluminum Alloys. E. M. Khairy and M. K. Hussein. *Corrosion 15,* 63t (1959) Feb. (5 pp.)

Studies of the static electrode potentials of the R, Duralumin, M 22, DK and S 2 aluminum base alloys show that these alloys have the same behavior as pure metal in buffer solutions initially free from metal ions within the *p*H range 1-8. Repetitive oscillographic method was used to examine the corrosive action of chloride ions on the anodic behavior of the alloys studied. Oscillograms are presented to show the potentials of the alloys in various *p*H ranges. Composition of the buffer solutions at various *p*H levels are given in tables.

Mechanical Properties and Corrosion Resistance of Oil Well Tubing. R. A. Prange. *Corrosion 15,* 49t (1959) Feb. (6 pp.)

Resume of applications of various grades of tubing in sweet and sour condensate wells and sweet and sour oil wells. Various modes of corrosion damage in the different tubing materials are discussed. Sour condensate wells are particularly troublesome since the sulfide stress cracking is closely related to the mechanical properties. Stress corrosion cracking may be a serious problem in the high strength materials. Mechanical properties and the effects on service are examined. Transverse notch ductility is a critical factor in high strength steels. Common defects found in the various grades are discussed.

Research on Corrosion Attack on Buried Pipelines. G. Eingrieber. *Gas- u. Wasserfach 100,* 157 (1959) Feb. 13 (5 pp. German text.)

Influence of soil on development and promotion of electrochemical corrosion on piping is reviewed from the basis of theoretical studies and from practical data of geophysics. The significance of specific soil resistivity and its measurement is critically treated. It is shown from theoretical and practical test results that the localization of corrosion damage is possible from results of geoelectric measurements. It is shown that pipeline studies by geoelectric methods on corrosion attack or corrosion risk can be an economic method.

Variable Interaction: A Statistical Solution. H. C. Bowen, C. Groot and J. L. Jaech. *Corrosion 15,* 83t (1959) Feb. (2 pp.)

Interaction may appear in an analysis of variance because of a poor choice of model. Effects of the independent variables in corrosion data seem to be multiplicative, which calls for a logarithmic transformation to convert this to an additive system. Simplification produced by such a transformation is strikingly illustrated in the analysis of a corrosion experiment. Experiment described was conducted to determine whether the occasional use of low purity water at low temperature would cause excessive corrosion in the cooling system of a power producing nuclear reactor. Three types of aluminum alloy were used in the corrosion tests.

Well Completion and Corrosion Control of High Pressure Gas Wells. NACE Tech. Comm. Report (Pub. 59-6). *Corrosion 15,* 73t (1959) Feb. (3 pp.)

Investigation of completion practices and corrosion control measures for gas wells with tubing pressures in excess of 5000 psi. Survey of 12 producing companies determined what had been done to combat the problem. Article reflects results of survey and includes data collected from 166 wells. Topics discussed include design problems in well installation, treatment with corrosion inhibitor efficacy evaluation, well characteristics, casing and tubing, programs and inspection methods. Data are given by company on the number of P-grade casing and tubing failures in service in well, failures occurring during hydrostatic tests, percent rejects of inspected pipe and cost of failures of casing and tubing.

Inhibitors

Corrosion Prevention. How Westcoast Prefilmed Sour Gas Lines. J. Joseph. *Gas 35,* 125 (1959) Mar. (4 pp.)

Problem for Canada's Westcoast Transmission Co. Ltd. was and is sour gas. To deliver its initial 400 MMCF/day (pressured by four compressor stations with a total 52,500 installed hp), the line needs a prodigious gas supply—and gets it from a complex gathering system. System's some 135 miles of 4- to 26-in. lines tap Alberta's "sweet gas" fields as well as half a dozen British Columbia fields whose output is essentially "sour gas"—a highly corrosive combine of natural gas and distillates (containing hydrogen sulfide, carbon dioxide, methane and ethane). Problem faced by Westcoast: How to protect its gathering system from blistering and pitting—and inevitable breaks. This was achieved by continuous feed of 10% amine inhibitor in diesel oil, ½ pint/MMCF, to form a film, and constant hydrogen-probe checking of the line.

Developments in Cooling Tower System Treatments. Part. I. Polyvalent Ion-Polyphosphate Inhibitors. J. I. Bregman and T. R. Newman. *Corrosion 15,* 97t (1959) Feb. (4 pp.)

Addition of certain metallic cations in very small quantities to synergized polyphosphate treatments in cooling tower systems will increase corrosion protection. This new approach is considered in detail with accompanying laboratory and field data. Data given include a comparison of corrosion inhibition by the polyphosphate and synergized inhibitors. effect of Zn, Cd, Cu and Sb ions on corrosion inhibition by synergized polyphosphates, and effect of metal dosage level. It was found that overdosing of the metal in some cases may remove any beneficial effects and may actually result in harm in some cases. Theoretical reasons for the effect of metal cations have yet to be established. It is likely, however, that cathodic inhibitors such as zinc may help prevent the formation of local cells at points on the metal surfaces where potential differences exist.

Sodium Silicate as a Corrosion Inhibitor in Gasholders. P. G. Clements and F. R. Jackson. *Gas J. 297,* 106 (1959) Jan. 21. (2 pp.)

Investigation has been conducted to study effect of addition of sodium silicate as a corrosion inhibitor in the water contained in gasholders. Over a 13-month period, steel test panels were hung in a silicate treated and untreated holder and removed at intervals for examination. Final results, while not wholly conclusive, suggest that the life of a holder would be increased materially by silicate dosage. In the case of unpainted steel, an increase in life of as much as 30-60% was indicated. Furthermore, it was noticed that the silicate treatment markedly reduced staining of the paint-work by red water. This may, in some cases, be more significant than actual corrosion inhibition and further work is to be carried out along these lines.

Insulation

Insulation of Pipe-lines to Carry Methane Must Be Thorough to Prevent Boiling-off. *Gas J. 297,* 100 (1959) Jan. 21.

One of the many problems to be surmounted at Canvey Island (England) is to prevent methane from boiling off, which it will do at normal pressure if its temperature rises to -258° F. In the pipeline carrying the methane from ship to storage tank, very thorough insulation is necessary to prevent undue evaporation and formation of vapor locks. The 10-in. aluminum alloy main, about 2000 ft. long, is covered with 6 in. of Onazote cellular insulation, which has a thermal conductivity of almost half that of cork. To insure that this performance is maintained, it is essential to keep the insulation absolutely dry for, as with all thermal insulation systems, full thermal efficiency depends on a complete and lasting water- and moisture-proof seal.

Plastics

Advantages of Reinforced Polyesters for Use on Highway Tank Trucks. *Corrosion 15,* 94 (1959) Feb. (2 pp.)

Advantages of reinforced polyester plastic tanks for use on trucks transporting chemicals, pharamaceuticals and foods are listed: lighter weight than alloys of comparable strength, greater resistance to corrosives, lower coefficient of heat transfer, lower maintenance costs and lower initial costs. Tanks now in service permit many efficiencies not available to those using alloy tanks. Results of extended service tests are included.

Coatings

Methods and Apparatus for Coating Pipe and the Like. R. H. Kuxhaus (assigned to Royston Lab. Inc.) U.S. 2,867,188 (1959) Jan. 6.

Pipe coating apparatus for finished pipelines is claimed which consists of a sleeve member placed over and spaced radially from the pipe. Each sleeve end is reduced to form a narrow annular ring. Coating material loaded into the sleeve through a flanged hatch is carried around the pipe by baffles and smoothed onto pipe by spring spreaders while the sleeve is rotated and moved lengthwise.

12. ANALYTICAL METHODS

Acetylene

Nonaqueous Determination of Acetylenic Hydrogen. L. Barnes, Jr. *Anal. Chem. 31,* 405 (1959) Mar. (4 pp.)

Method is devised for the nonaqueous determination of acetylenic hydrogen. It is based on the liberation of hydrogen ions from the reaction between nonsubstituted acetylenic compounds and silver perchlorate. Perchloric acid formed is titrated to an end point using thymol blue indicator.

Analytical Instruments

Improved Titrilog Sensitivity. J. S. Nader and J. L. Dolphin. *J. Air Pollution Control Assoc. 8,* 336 (1959) Feb. (2 pp.)

Titrilog, as a result of recommended modifications, had its sensitivity improved by a factor of more than 10. Sensitivity was shown to have a potential improvement factor of more than 2000 if the background noise level were reduced to an insignificant level. Probable sources of noise were noted, indicating that their effects may be minimized by a selective choice of critical electronic components.

Improved Titrilog Sensitivity. Part II. Field Performance and Evaluation. H. C. McKee and W. L. Rollwitz, *J. Air Pollution Control Assoc. 8,* 338 (1959) Feb. (3 pp.)

Titrilog instrument was modified for field use, to increase sensitivity by a factor of 10. Noise level was reduced to a satisfactory level by an electronic filter. Drift of the zero point was the greatest difficulty encountered, and occasionally no record was obtained when the zero point drifted off the scale for brief periods. No excessive maintenance problems were encountered in five months' operation.

Three New Spectrophotometers. E. Luscher. *Appl. Spectroscopy 12,* 172 (1959) No. 6 (3 pp.)

Spectrophotometers are being used more frequently and for more applications in industrial and research laboratories. Therefore, it becomes more important to build various spectrophotometers for specialized applications. Three new commercial spectrophotometers are described: Interference filter colorimeter (range 400-700mμ); prism spectrophotometer (range 300-750mμ) and silica prism-glass prism-grating spectrophotometer (range 210-5000mμ).

Chromatography

Determination of Total Gaseous Pollutants in Atmosphere. P. W. West, B. Sen and B. R. Sant. *Anal. Chem. 31,* 399 (1959) Mar. (3 pp.)

Rapid chromatographic method is developed for determining total gaseous pollutants in atmosphere. Material is introduced into a helium stream which passes through an empty tube in the apparatus. Emergence times, peak heights and areas under the curves are recorded and calculations made from these factors.

Exhaust Gas Analysis by Gas Chromatography Combined with Infrared Detection. W. B. Heaton and J. T. Wentworth. *Anal. Chem. 31,* 349 (1959) Mar. (9 pp.)

Combination of gas chromatographic separation and sensitive infrared detection is used in the analysis of automobile exhaust gas. After leaving the chromatographic column, the gas is burned, converting the hydrocarbons to carbon dioxide and water. Then it is passed through an infrared analyzer. Peaks are obtained from hydrocarbon concentrations as low as 1 ppm.

Gas Chromatography in the Oilfield. H. Gilmour and R. W. Snell. *Petrol 22,* 65 (1959) Feb. (2 pp.)

Knowledge of gas constituents in oilfield natural fluids is essential in good reservoir engineering practice, and a simple method of analyzing gas samples from field separators enables adequate, on-the-spot control to be applied. Chromatographic techniques are superseding the complex and laborious Podbielniak fractional distillations used in the past. Simple and inexpensive apparatus, which is ideal for field and laboratory use, is described.

Gas-Liquid Chromatography. C. S. G. Phillips. *Petrol. 22,* 91 (1959) Mar. (4 pp.)

Technique of gas-liquid chromatography was invented by James and Martin in 1952, and has since been widely applied as an analytical tool of exceptional power. Its use has been particularly marked within the petroleum industry, first of all in research and later in plant laboratories. Despite its late appearance, the technique is based on extremely simple principles and requires only relatively inexpensive apparatus.

Gas-Liquid Chromatography. Determination of Column Efficiency. H. W. Johnson, Jr. and F. H. Stross. *Anal. Chem. 31,* 357 (1959) Mar. (7 pp.)

In gas-liquid chromatography, it is essential to separate the peak width into column and noncolumn effects. A magnitude of errors may arise when the entire peak width is attributed to the column alone. Repeatability of peak width is compared with that of partition coefficients. Method is described for estimating column peak width.

A New Application for Chromatography in Gas Analysis. W. Virus. *Erdol u. Kohle 11,* 867 (1958) Dec. (2 pp. German text.)

New German instrument, the Gasofract-Gaschromatograph, is presented and discussed. Principles, operating procedure, construction and recording methods are given, and use of 23 different column

materials is outlined for application to gases and liquefied gases.

Clay

Use the Thermobalance in the Analysis of Soils and Clays. M. Schnitzer, J. R. Wright and I. Hoffman. *Anal. Chem. 31,* 440 (1959) Mar. (5 pp.)

Thermogravimetry of soils, relatively pure clays, crystalline carbonates and soils to which clays and carbonates are added is studied. Technique is applicable to determinations of hygroscopic moisture, organic matter and inorganic carbonates in soils, and lattice water in clay minerals.

Hydrocarbons

Continuous Monitoring of Hydrocarbon Contaminants in Low Temperature Air Separation Plants. G. S. Cochrane and E. J. Rosenbaum. *Chem. Eng. Progress 55,* 54 (1959) Feb. (5 pp.)

To insure safe operation of an air plant it is necessary to frequently measure the concentration of contaminants in process streams. Considerable attention has been paid to such explosion initiators as ozone and acetylene, but it is also imperative to keep the quantity of hydrocarbon fuel within safe limits.

Infrared Spectroscopy

Far Infrared Spectra of H_2O and H_2S Taken with an Interferometric Spectrograph. G. A. Vanasse, J. Strong and E. Loewenstein. *J. Optical Soc. Am. 49,* 309 (1959) Mar. (2 pp.)

Large (12-in. aperture) interferometric spectrograph has been constructed at Johns Hopkins University (Maryland) for far infrared spectroscopy. It consists of a lamellar grating of variable groove depth in an Ebert optical system, worked near normal incidence. Detector receives illumination only from the zeroth grating order. This illumination is modulated as the groove depth is varied.

Mass Spectrometer

Comparisons of Spectra from Different Types of Mass Spectrometers. V. J. Caldecourt. *Appl. Spectroscopy 12,* 167 (1958) No. 6 (5 pp.)

Comparison of the cracking patterns of various compounds taken on different types of mass spectrometers shows large differences. Mass discrimination is a large factor, and this is to be expected, particularly when comparing 180° with 60° or 90° instruments. Variations because of the nature of the compounds also are evident.

Particle Size

Particle Size Analysis by Gamma-Ray Absorption. C. P. Ross. *Anal. Chem. 31,* 337 (1959) Mar. (3 pp.)

Method for determining particle size for any subsieve particles is described using gamma-ray absorption. Uranium oxide is analyzed and the data according to Stokes' law indicates its particle size to be about ±0.3 micron. Only provision for analysis is that the absorption coefficient of the particles and the suspending medium differ significantly.

Radioactivity Applications

Radioactive Tracers Determine Gas Flow. *A.G.A. Monthly 41,* 4 (1959) Mar. (2 pp.)

Sponsored by the A.G.A. Pipeline Research Committee, developed by the Institute of Gas Technology and first tested in cooperation wtih Panhandle Eastern Pipe Line Co., program for application of radioactive tracer techniques to determine flow will aid greatly in proper design of pipeline extensions or new facilities as well as give an indication of deterioration of the pipeline.

The Statistics of Radioactivity Measurement. A. C. Kuyper. *J. Chem. Education 36,* 128 (1959) Mar. (5 pp.)

Attempt to provide a unified discussion of the statistical considerations fundamental to radiation counting. By application of statistics, it is possible to determine the probability with which the observed rate corresponds to the true average rate of disintegration of a radioactive sample. Topics considered include statistical error as a function of the total count and as a function of the counting rate; the error introduced by the background, and assessment of counting behavior.

Use of Radioisotopes in the College Chemistry Laboratory. D. Phillips and R. H. Maybury. *J. Chem. Education 36,* 133 (1959) Mar. (4 pp.)

Article describes experiences of authors with the cylindrical Geiger tube. Remarkable sensitivity of tube (a meaningful count is obtainable from ordinary potassium salts in the laboratory) opens up the possibility of "spiking" many of the reagents in a laboratory with isotopes at the microcurie level so that radiochemical techniques may supplant conventional techniques in many experiments.

Sulfur

Determination of Microgram Quantities of Sulfur by Reduction with Raney Nickel. L. Granatelli. *Anal. Chem. 31,* 434 (1959) Mar. (3 pp.)

Organically bound sulfur is determined by a rapid, sensitive titrimetric method. Sulfur in nonolefinic hydrocarbons is reduced with Raney nickel, the hydrogen sulfide produced is liberated and titrated

with mercuric acetate. Analysis is accurate for as little as 5 gamma of sulfur.

Water

Microdetermination of Water by Titration with Fischer Reagent. E. L. Bastin, H. Siegel and A. B. Bullock. *Anal. Chem. 31,* 467 (1959) Mar. (7 pp.)

Microtitration technique and apparatus is described for determination of water with Karl Fischer reagent. Special design eliminates contamination due to atmospheric moist air. Measurable concentration of water ranges from 100 to 0.0:% in milligram or gram samples, with precision of ±1%.

X-Ray Methods

Using K-Capture X-Rays to Analyze Products in the Plant. A. Beerbower. *Control Eng. 6,* 128 (1959) Mar. (4 pp.)

K-capture process generates X-rays as a result of the radioactive decay of an isotope source. Physicists have known about this process for many years, but only within recent past has the *K*-capture X-ray been used for analyzing liquid and gas streams in the plant. Article first reviews the *K*-capture process, describes equipment design in detail and discusses sampling considerations. It is then shown how equipment has been successfully used for measuring ammonium chloride content in scrubbing tower wash water, and for determining calcium (sulfated ash) content in the manufacture of petroleum products.

Gas Analysis

Apparatus for Separating, Identifying and Measuring Gases. L. V. Guild. U.S. 2,868,316 (1959) Jan. 13.

Laboratory fractionating column for separating components of gas mixtures is claimed which consists of a tapered charcoal adsorption column with a thermal conductivity cell as a detector at column outlet and a controlled mercury-flow orifice to drive a displacement vapor over the charcoal and move the lighter fractions out into a measuring chamber.

13. BASIC SCIENCE

Absorption

Absorption and Humidification. C. Y. Wen and M. Leva. *Ind. Eng. Chem. 51,* (Chem. Eng. Rev.) 337 (1959) Mar. (3 pp.)

Increased activity on flow dynamics in towers and emphasis on interpretation of mass transfer phenomena were noted in the literature, with new theories based on flow characteristics prominent. Interest in carbon dioxide absorption continued, while only modest activity in the field of humidification was observed.

Adsorption

Adsorption. B. L. Harris. *Ind. Eng. Chem. 51,* (Chem. Eng. Rev.) 340 (1959) Mar. (4 pp.)

Adsorption processes are gaining ground for industrial separations. Gas phase chromatography is an accepted tool for limited process control and bids fair to be applicable to automatic control in the future. Five-part bibliography of 193 items is classified into industrial separations, gas chromatography, liquid-phase studies, preparation of adsorbents and miscellaneous.

Influence of Lattice-Defect Density on the Chemisorption and Oxide Formation on a Clean (100) Crystal Face of Nickel as Determined by Low-Energy Electron Diffraction. H. E. Farnsworth and J. Tuul. *Phys. and Chem. of Solids 9,* 48 (1959) Jan. (9 pp.)

Atomically clean, carbon-free (100) single-crystal face of nickel was obtained by outgassing in high vacuum, argon-ion bombardment and subsequent annealing. As the exposure to oxygen was increased from 10^{-6}mm Hg–min at 25°C, adsorption occurred first in a double-spaced face-centered, crystalline lattice, then in a single-spaced, simple-square lattice, and finally in a nickel-oxide lattice. Intensities of the diffraction patterns from the adsorbed structures were much greater for a surface having a high defect density than for one having a low defect density, although the exposures required to produce detectable amounts of the structures were approximately independent of the defect density.

An Infrared Study of the Water-Silica Gel System. H. A. Benesi and A. C. Jones. *J. Phys. Chem. 63,* 179 (1959) Feb. (4 pp.)

Infrared study of bound and adsorbed water in silica gel was conducted. It was found that hydrogen in silica gel could be completely replaced by deuterium upon treatment with D_2O at room temperature. Deuteration of silica gel allowed unambiguous differentiation between absorption bands arising from silica itself and those arising from atomic groupings that contain hydrogen. It was found that "bound water" in silica gel consists entirely of SiOH groups located on the surface. Infrared spectrum of physically adsorbed water closely resembles that of liquid water. Dehydration of silica gel at high temperatures removes surface SiOH groups; these can be reconstructed by reaction with adsorbed water at room temperature.

Tests with Low-Energy Electron Diffraction for Adsorbed Hydrogen and Nickel Hydroxide Formed on

the (100) Surface of a Nickel Crystal at 25°C. H. E. Farnsworth, R. E. Schlier and J. Tuul. *Phys. and Chem. of Solids 9,* 57 (1959) Jan. (3 pp.)

Low-energy electron-diffraction pattern from a chemisorbed double-spaced monolayer was observed subsequent to an exposure to hydrogen, only when a hot filament was present during the exposure, thus indicating adsorption of atomic hydrogen or water vapor or both. Evidence is presented which indicates that this double-spaced structure was due to water vapor. Adsorption of hydrogen on some parts of the surface, with no hot filamen: present during exposure, was confirmed by consecutive exposures of the clean nickel surface to hydrogen and oxygen to form $Ni(OH)_2$.

Calorific Valve

Chart Speeds Estimation of How Many B.t.u.'s in Natural Gas. R. D. Northcutt and G. M. Couch. *Oil Gas J. 57,* 161 (1959) Mar. 9 (3 pp.)

Article deals with quality provisions and specifically the heating value of natural gas. Graphic approach provides a means of rapidly determining the approximate heating value (Btu) of a natural gas sufficiently accurate and usually within the limits required for most evaluations, provided the gas is essentially free of sulfur and hydrogen impurities. Closer estimation of impurities as related to the heating value would be necessary to obtain the maximum amount of accuracy.

Diffusion

Diffusion Coefficients in Hydrocarbon Systems, Methane in the Liquid Phase of the Methane-Santa Fe Springs Crude Oil System. H. H. Reamer and B. H. Sage. *J. Chem. Eng. Data 4,* 15 (1959) Jan. (7 pp.)

Investigation reported deals with measurements of the Fick diffusion coefficient of methane in the liquid phase of the methane-Santa Fe Springs crude oil system at pressures up to 3600 psi in the temperature interval between 40° and 280°F. Upper limit of pressure was established by the possible separation of an asphaltic phase.

Fluid Flow

Experimental Investigation of Turbulent Pipe Flow with Coolant Injection. S. W. Yuan and A. Barazotti. *Heat Transf. and Fluid Mech. Inst. 25,* Univ. of Calif. (1958) June (15 pp.) (From *Appl. Mech. Rev. 12,* 128 (1959) Feb.)

Air was injected through porous walls of a pipe and measurements were made of axial pressure distribution, wall temperature and of radial velocity and temperature profiles. Temperature range of main flow was between ambient and 900 F and Reynolds number was varied up to 300,000. Results show that profiles can be predicted if axial pressure gradient, maximum velocity at center of pipe and an empirical constant are known from experiment. Statement is made that since wall-friction coefficient increases with coolant injection whereas heat-transfer coefficient decreases with increased injection, analog between heat transfer and momentum transfer does not exist in this type of flow. Reviewer notes that skin-friction coefficient is based on conditions upstream of injection and that if the coefficient were based on local properties, the coefficient would decrease with injection. Hence, conclusion regarding Reynolds analogy is questioned.

W. F. Davis, USA

Flow of Fluids. M. Weintraub. *Ind. Eng. Chem. 51,* (Chem. Eng. Rev.) 362 (1959) Mar. (8 pp.)

Fluid-motivated solids transport is receiving increased attention—long-distance conveyance is of special interest in U. S. and short-distance problems are the concern of foreign investigators. Interest in two-fluid systems is highlighted by establishment of a project on flow of vaporizing mixtures. Five-part bibliography (single-phase flow, meters and controls, flow through porous media, multiphase flow and mechanical design) cites 226 references.

Fluid Dynamics. A. K. Oppenheim, C. V. Sternling, C. A. Sleicher, Jr. and R. A. Stern. *Ind. Eng. Chem. 51,* (Chem. Eng. Rev.) 437 (1959) Mar. (16 pp.)

Literature indicates that study of turbulence is characterized by a variety of approaches, as illustrated in turbulent diffusion in free flows and flow in ducts. Fine structure of turbulence and large-scale turbulent motions also are studied. Ranque-Hilsch tube continues to attract attention, as does vortex motion. Boundary layer separation studies from worldwide sources show surge of interest. Transition from laminar to turbulent boundary layers also received attention. Extensive bibliography is included.

Instrument Scale Error Study Throws New Light on Flowmeter Accuracy. W. Buzzard. *Chem. Eng. 66,* 147 (1959) Mar. 9 (4 pp.)

In selection of flow instruments, mechanics of the sensing unit are usually considered, but nature of the instrument scale frequently is overlooked. Instrument scale is result of physical relationship between flow rate and measured variable (pressure drop, variable area, or head across the measuring element.) It is important to consider scale because indicated flow rate accuracy, and therefore control accuracy, is dependent upon it.

Molecular Transport Properties of Fluids. E. F. Johnson. *Ind. Eng. Chem. 51,* (Chem. Eng. Rev.) 399 (1959) Mar. (3 pp.)

Oscillating-body viscometers and hot-wire equipment for thermal conductivity were the most popular for experimentation. Many new modifications of old methods of measurement were introduced, and one novel viscometer was described in the literature which involves a bearing with its movable member driven by a galvanometer coil. Many equations have been proposed and old ones tested. Reliable reduced-state graphical correlations for the thermal conductivity of simple gases are available. A new book provides a useful and practical summary of the best current methods for predicting viscosities and thermal conductivities as well as many other properties of gases and liquids.

Some Properties of Boundary Layer Flow During the Transition from Laminar to Turbulent Motion. S. Dhawan and R. Narashimha. *J. Fluid Mech. 3,* 4 (1958) Jan. (19 pp.) (From *Appl. Mech. Rev. 12,* 120 (1959) Feb.)

Transition in the boundary layer on a flat plate is examined from the point of view of intermittent production of turbulent spots. On the hypothesis of localized laminar breakdown, for which there is some experimental evidence, Emmons' probability calculations can be extended to explain the observed statistical similarity of transition regions. Application of these ideas allows detailed calculations of the boundary-layer parameters, including mean velocity profiles and skin friction during transition. The mean velocity profiles belong to a universal one-parameter family with the intermittency factor as the parameter. From an examination of experimental data the probable existence of a relation between the transition Reynolds number and the rate of production of the turbulent spots is deduced. A simple new technique for the measurement of the intermittency factor by a Pitot tube is reported.

From authors' summary by M. H. Bertram, USA

Turbulent Motion in a Cylindrical Pipe. D. G. Zhen'. *Sb. Nauch. Rabot. Stud. Nauch., o-vo Leningr. in-ta Inzh. Vod. Transp.* 28 (1956) No. 1 (6 pp. Russian text.) (From *Appl. Mech. Rev. 12,* 121 (1959) Feb.)

Author studies the problem of the distribution of velocities in turbulent uniform steady motion in pipes, starting from concepts explained in another of his papers (title source, No. 1, p. 5, 1956). A formula is suggested for the velocity profile. This formula is compared with the test data of F. A. Shevelev on the distribution of velocities in new steel and cast-iron tubes, while a satisfactory agreement between test and theory is established. It should, however, be noticed that the influence of the Reynolds number on the velocity distribution, which is very marked for new steel and cast-iron pipes, is not reflected in author's formula.

A. D. Al'tshul'
Courtesy, Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Heat Transfer

Condensing and Boiling Coefficients. N. H. Chen. *Chem. Eng. 66,* 141 (1959) Mar. 9 (6 pp.)

Condensing and boiling coefficients of heat transfer can be evaluated graphically using as a basis equations that are either 1) purely theoretical or 2) empirical but not completely proved. Nevertheless, when properly applied, these graphical short-cuts save time and effort and will provide answers that agree quite well with experimental data.

Effect of Gas Flow on Temperature Distribution of Heat in Nonuniform Bars with Varying Cross Section. G. A. Tirskii. *Izv. Akal. Nauk SSSR, Otd. Tekh. Nauk.* 70 (1957) Jan. No. 1 (7 pp. Russian text.) (From *Appl. Mech. Rev. 12,* 129 (1959) Feb.)

The problem, considered as one-dimensional, leads to solving an ordinary differential equation of the second order, with variable coefficients. After transforming the equation, author uses for its solution the method of a small parameter: the unknown function is assumed in the form of a finite series in power of the small parameter ϵ. First of all, author finds an approximate solution of the homogeneous equation, then of the nonhomogeneous one, simultaneously with the estimation of the error. Author then presents a numerical example, estimates the error caused by using the approximate method and shows that this error can be made as small as we like. An analysis of the results obtained is presented at the end.

K. Rektorys, Czechoslovakia

Equations of Heat Transfer in Turbulent Flow in Pipes. E. Rukenshtein. *Izv. Akad. Nauk. SSSR, Otd. Nauk* 23 (1956) May (6 pp. Russian text.) (From *Appl. Mech. Rev. 12,* 130 (1959) Feb.)

Rukenshtein considers equation of heat transfer in turbulent flow in pipes. After introducing the notion of the mean temperature in a cross section and of the heat flux and modifying the heat equation correspondingly, Rukenshtein discusses characteristic numbers of the system: Prandtl and Nusselt numbers.

M. Z. v.Krzywoblocki, USA

Heat Transfer. E. R. G. Eckert, J. P. Hartnett and T. F. Irvine, Jr. *Ind. Eng. Chem. 51,* (Chem. Eng. Rev.) 453 (1959) Mar. (13 pp.)

Number of articles in the field of heat transfer, which in 1957 already exceeded 1000, is still on the increase. Translations of articles from Soviet technical periodicals are now also available to a considerable degree. Large quantity of publications made it necessary to restrict presentation in review to articles dealing with heat transfer and omit those which cover physical processes even when they are intimately connected with energy transfer like boundary layer flow, thermal properties, etc. Bibliography of 311 items cites references in fields of conduction, channel flow, boundary layer flow, flow with separated regions, transfer mechanism, natural convection, convection from rotation surfaces, mass transfer cooling, change of phase, liquid metals, radiation, measurement techniques and heat transfer applications.

Heat Transfer Nomographs. Part 5. Nusselt Numbers for Liquids and Gases. J. Alvarez and C. Duhne. *Petrol. Refiner 38,* 157 (1959) Feb. (2 pp.)

Functions in the heat transfer coefficient include an elusive factor called the Nusselt number. Use of two nomographs presented enables rapid determination of this factor.

Quick Chart for Heat Transfer Rates. F. L. Rubin. *Petrol. Refiner 38,* 155 (1959) Feb. (2 pp.)

Design chart has been prepared for ¾-in. O.D. tubes arranged on a 15/16-in. triangular pitch with specific heat of the fluid at 0.50 and thermal conductivity of 0.075. Chart gives factors for the Donohue equation used in finding heat transfer rates for fluids flowing across tubes in baffled heat exchangers. Especially adaptable to liquids, chart gives answers in standard engineering units.

The Utilization of Waste Heat. J. H. Potter. *Mech. Eng. 81,* 54 (1959) Feb. (5 pp.)

Movement of waste product involves an energy input which is often overlooked in superficial analyses of heat-recovery schemes. Power consumed by fans, compressors, pumps, grates, etc., must be charged against recovery system, as well as the heat leakages and pressure losses in the connecting lines. Sound waste heat utilization should be built around a continuous rather than a batch process, and it should contribute either to the process itself or to auxiliary operations. Gas, liquid, vapor or solid may be used to absorb heat from a high temperature source; this heat then can be physically conveyed or transported to a lower temperature receiver. Sixty-item bibliography is cited.

Hydrocarbons

For Condensed Cyclic Aromatics . . . Predict Hydrogenation Aromatics. A. Bondi. *Petrol. Refiner 38,* 161 (1959) Feb. (3 pp.)

Heats of formation of condensed cyclic naphthenes are rarely available, and can hardly be predicted with any degree of reliability. Recourse is had, therefore, to the effect of resonance stabilization on the heat of hydrogenation of unsaturated compounds, first discussed by Kistiakowsky, Vaughn et al. Care must only be taken that a consistent choice of heat of hydrogenation per olefinic double bond of reference olefin and resonance energy of the aromatic molecule is made. If that is done, rather good predictions of heats of hydrogenation are possible.

Hydrogen

How Linde Makes Heavy Water from Hydrogen. *Chem. Eng. 66,* 68 (1959) Feb. 23 (3 pp.)

For the first time, German Linde discloses how its hydrogen distillation process works successfully in a commercial heavy-water plant. Farbwerke Hoechst A.G. announced late last year that their 6-ton/yr plant designed for them by German Linde was operating successfully. Because of its success, India's Nangal Fertilizer and Chemicals, Ltd., licensed the process for the 14-ton/yr heavy water plant, now under construction.

The Kinetics of the Evolution and Dissolution of Hydrogen at Electrodes. J. O'M. Bockris and H. Mauser. *Can. J. Chem. 37,* 475 (1959) Feb. (14 pp.)

Kinetics of the electrolytic evolution of hydrogen at electrodes have been treated previously only in an approximate way, or upon the assumption that only one step influences the reaction rate, or without regard to H coverage. Work reported in this article is concerned with a rigorous treatment of the kinetics of two probable paths for cathodic and anodic reactions of hydrogen at electrodes, with attention to evaluation of quantities which are open to experimentation and have values specific to certain reaction mechanisms.

Liquefaction

Missile Components Tested at New Gaseous Oxygen Laboratory. A. L. Spangenberg. *Ind. Laboratories 10,* 100 (1959) Mar. (5 pp.)

New cryogenics laboratory will serve entire industry for environmental and functional studies of air and space borne components. Test chamber of gaseous oxygen laboratory provides for a complete series of tests for simulating both environment and function. Environmental simulations include cryogenic and high temperatures, vibration, thermal shock, humidity and acceleration.

Tensile Strengths of Liquid Argon, Helium, Nitrogen, and Oxygen. J. W. Beams. *Phys. of Fluids 2,* 1 (1959) Jan.-Feb. (4 pp.)

Tensile strengths of several liquids, at low temperatures were measured by a linear deceleration method. Values found were as follows (expressed in atmos:) argon -12, nitrogen -10, oxygen -15, and helium -0.16. Values are somewhat lower than those calculated from the theory.

Mass Transfer

Mass Transfer. C. R. Wilke, J. M. Prausnitz and A. Acrivos. *Ind. Eng. Chem. 51,* (Chem. Eng. Rev.) 466 (1959) Mar. (6 pp.)

Articles of particular interest published in 1958 are those which clearly point out new areas in the field where further knowledge is needed. Among these are the general subject of longitudinal dispersion and particularly its influence in packed bed operations; and the distribution of turbulence scales and its importance in mixing and homogeneous reactions. Potential utility of boundary layer methods in the fluid mechanical analysis of mass transfer phenomena is gaining increasing recognition. Number of studies have pointed up important role of interfacial phenomena and particularly the fluid motion induced by surface tension forces. Increasing emphasis has been placed on mathematical analysis and experiments directed toward the gaining of a fundamental understanding of mass transfer mechanisms.

Mathematical Methods

Computers, Mathematics, Statistics, and Operations Research. R. C. Johnson, W. F. Burggrabe, Jr., R. L. Heiny, J. L. Russell and R. F. Sweeny. *Ind. Eng. Chem. 51,* (Chem. Eng. Rev.) 422 (1959) Mar. (10 pp.)

Review aims to cover papers which are of direct interest and application, and to review them from the viewpoint of the reader. Many important theoretical papers and certain specialized areas also are omitted because they do not have direct application. Two major areas of development are increased interest in chemical and physical fundamentals and application of systems analysis and servomechanisms theory to control of chemical processes. Extensive bibliography is included.

Phase Equilibria

Cluster Theory of Vapor-Liquid Equilibria. B. C. Y. Lu, J. C. M. Li and T. W. Ting. *Ind. Eng. Chem. 51,* 219 (1959) Feb. (4 pp.)

Algebraic equations for extrapolating, smoothing and predicting vapor-liquid equilibrium data suffer from laborious calculations or lack of theoretical considerations. Article reports on study in which general equations are developed theoretically, with the postulation that deviations from ideal behavior of vapor-liquid equilibria are due to formation of clusters in the liquid and vapor phases. Equation derived from binary systems can be reduced to the ideal case and to useful empirical equations. Theory has been applied to prediction of ternary vapor-liquid equilibrium data, using as primary information binary vapor-liquid equilibrium data for three components.

Ideal Critical Volume for Generalized Correlation. Application to the Macleod Equation of State. K. A. Kobe and P. S. Murti. *Ind. Eng. Chem. 51,* 332 (1959) Mar.

Values of critical volume are less abundant and less accurate than values of critical temperature and pressure. Ideal critical volume of Su would serve better as a correlating value. The V_{ci} concept was applied to the Macleod equation of state in the generalized form developed by Rush and Gamson. Four constants of the Macleod equation correlated better using the ideal critical volume than the actual critical volume. Analytical expressions are given for these constants. It is suggested that the V_{ci} concept be tried for all correlations involving critical or reduced volume as a correlating factor.

Low Temperature Vapor-Liquid Equilibrium in Light Hydrocarbon Mixtures: Methane-Ethane-Propane System. A. R. Price and R. Kobayashi. *J. Chem. Eng. Data 4,* 40 (1959) Jan. (13 pp.)

Study was conducted to obtain phase equilibria data at low temperatures to supplement the data above and provide a basis for the evaluation of correlations for low temperature *K-values.* The ternary methane-ethane-propane system was selected because of its basic, yet multicomponent nature. Six temperatures were under investigation, extending from 50° down to -200°F. Pressures at 100 and 200 psi intervals up to the critical states were chosen.

Multicomponent Vapor-Liquid from Binary Data. C. Black. *Ind. Eng. Chem. 51,* 211 (1959) Feb. (8 pp.)

Importance of efficient use of binary data in representing multicomponent equilibria cannot be overemphasized. Where binary data alone can furnish information to calculate multicomponent phase equilibria, coefficients depending on data for ternary, or multicomponent, mixtures should not be introduced. Modified van Laar-type equations for the activity coefficients are applied to calculation of vapor-liquid equilibria in ternary and multicomponent mixtures. Equations have a maximum of three coefficients for each binary and the binaries

constituting a ternary or multicomponent system are related, the extent depending on the component types. Five examples, ranging from ternary to eight-component mixtures with various types of components, show that pure component and binary data alone can provide reliable results for multicomponent mixtures.

Phase Equilibria Molecular Transport Thermodynamics. J. C. Elgin and J. J. Weinstock. *J. Chem. Eng. Data 4,* 3 (1959) Jan. (10 pp.)

Article presents liquid-liquid and liquid-vapor phase equilibrium data at 15°C for pressures in the range from 0-1000 psig for a number of typical three-component systems comprised of ethylene, water and various organic liquids. It describes conditions and compositions existing in several water-organic liquid mixtures which are normally either partially or completely miscible when they are subjected to ethylene under pressure. It further presents a generalization of the phase equilibrium behavior in three-phase patterns (typical isotherms which cover all of the 26 systems studied.

Porosity

An Instrument for the Measurement of Pore-Size Distribution by Mercury Penetration. N. M. Winslow and J. J. Shapiro. *ASTM Bull. No. 236,* 39 (1959) Feb. (6 pp.)

Instrument for routine determination of pore-size spectra by mercury intrusion is discussed. Penetration is measured by direct volumetric readings made through transparent walls of a pressure chamber on the calibrated stem of a penetrometer containing the sample within the instrument. Controlled stepwise pressuring is obtained by means of a hand-operated pressure generator, which is part of the self-contained hydraulic system of the instrument, operable without auxiliary apparatus other than analytical balance and vacuum pump. Procedure requires about one-half hour for a complete determination. Several typical pore spectra of a variety of common materials are shown.

Thermodynamics

On the Calculation of Properties of Gases at Elevated Temperatures. I. Amdur and J. Ross. *Combustion and Flame 2,* 412 (1958) Dec. (9 pp.)

Role of the potential of intermolecular force in determining properties of gases at elevated temperatures is discussed, and the following points are emphasized. 1) The calculation of accurate values of such properties requires potential parameters which are valid at interaction distances which are important at the temperatures in question. 2) Extrapolation of potentials obtained from low temperature properties for calculation of high temperature properties is, in general, not justified, and leads to values of transport coefficients and second virial coefficients which differ considerably from those calculated from potentials based on the elastic scattering of high energy molecular beams. 3) The high temperature range, in which such beam potentials are useful, is not determined by the kinetic energy of the beam particles, but by the small fraction of this energy which is converted into potential energy in the scattering process.

Thermodynamics. J. M. Smith and G. M. Brown. *Ind. Eng. Chem. 51,* (Chem. Eng. Rev.) 472 (1959) Mar. (9 pp.)

Research and development activities on the fuel cell promise more efficient power production. Thermoelectric generators and thermoelectric cooling equipment will be commonplace in another decade. Data on high energy fuels and thermodynamic properties at high temperatures are aiding the missile program. Extensive bibliography cites 321 references.

Thermodynamic Properties of Gases at High Temperature: 1. Chemical Equilibrium Among Molecules, Atoms and Atomic Ions Considered as Clusters. H. W. Woolley. *J. Research 61,* 469 (1958) Dec. (22 pp.)

Equilibrium thermodynamic properties of gaseous mixtures at high temperatures are treated by an extension of the cluster theory of Ursell, omitting the assumption of additivity of pair energies. Effective partition function is introduced, which is a convenient function in expressing the increase of the partition function for the entire gas due to the joining together of the parts of the cluster. Law of mass action and dependence of second and third virial coefficients upon the cluster integrals for pairs and triples of molecules in a mixture have been obtained therefrom. Extension to a partially ionized gas is made by incorporating Mayer's cluster-based extension of the Debye-Huckel theory.

Ultrasonics

Emulsification and Dispersion Using Ultrasonics. J. S. Smith. *Chem. Process Eng. 40,* 54 (1959) Feb. (4 pp.)

Most important developments in liquid processing by ultrasonics have been in use of liquid whistles based upon original work carried out in Germany. Process was introduced in England in 1952. Device was first industrial unit which made liquid processing by ultrasonics possible at an economical figure. Continuous research and development, based upon six years of industrial experience by its manufacturers, has produced a range of machines capable of dealing with a wide variety of applications.

Ultrasonics and Welding. J. N. Antonevich and R. E. Monroe. *Battelle Tech. Review 8,* 9 (1959) Mar. (5 pp.)

Ultrasonic energy has provided one of the more promising new metals-joining techniques and a means for improving existing welding methods. Currently, ultrasonic welding is in limited use only. Research now under way, however, is expected to give technologists a better understanding of the mechanisms involved and help to hasten the practical application of ultrasonics in welding.

Vapor Pressure

Semiempirical Vapor Pressure Relation Based on Dieterici's Equation of State. J. J. Erpenbeck and D. G. Miller. *Ind. Eng. Chem. 51,* 329 (1959) Mar. (3 pp.)

Approximate three-constant vapor pressure relation has been derived from Dieterici's equation of state. This relation fits data for various substances of widely differing chemical nature satisfactorily from the triple point to the boiling point. Constant C is close to unity for all substances tested. If arbitrarily taken as 1.000, resulting two-constant equation gives good but not as close fit as the three-constant equation. Heats of vaporization calculated from the three-constant equation agree with experimental values within 5% in all but two cases. Closeness of fit approaches that of the Antoine equation over similar ranges.

Vaporization

Estimate Latent Heats Rapidly. C. C. Li and L. N. Canjar. *Petrol. Refiner 38,* 233 (1959) Jan. (3 pp.)

Heightened interest has been evident recently in the more accurate correlation of the P-V-T and related thermodynamic properties of chemical compounds using reduced properties as parameters. However, in most investigations, the important quantity, the latent heat of vaporization has been to some extent neglected or left to be calculated from estimated saturated vapor and liquid volumes in conjunction with vapor pressure data through the Clapeyron equation. Direct method of estimating heats of vaporization as a function of temperature or pressure is possible.

Viscosity

High Temperature Gas Viscosities. II. Nitrogen, Nitrogen Oxide, Boron Trifluoride, Silicon Tetrafluoride, and Sulfur Hexafluoride. C. P. Ellis and C. J. G. Raw. *J. Chem. Phys. 30,* 574 (1959) Feb. (3 pp.)

Viscosities of nitrogen (from 700°-1000°), nitric oxide (from 100°-1000°, boron trifluoride (from 180°-500°), silicon tetrafluoride (from 200°-330°) and sulfur hexafluoride (from 200°-850°) have been measured using a specially constructed silica apparatus. In addition, previous results for SiF_4 were recalculated in the low-temperature range down to room temperature. Results are discussed from point of view of intermolecular forces, and the molecular interaction parameters are compared with those calculated from data on gas viscosities in the lower temperature ranges. Results show the temperatures at which thermal dissociation of the compounds becomes important, and the viscosity measurements are not carried very far beyond these temperatures.

Vaporization

Submerged Flame Evaporator. F. L. Holderreed and R. E. Sullivan (assigned to The Anaconda Co.) U.S. 2,867,972 (1959) Jan. 13.

Evaporation of solutions by submerged combustion is improved by use of serrated or slotted edges on the dip nozzle so that combustion gas stream is broken into various sized bubbles with less vibration and flow volume.

Water

Water Treatment. Part 2. R. H. Marks. *Power 103,* 65 (1959) Mar. (24 pp.)

Broadly viewed, industry uses water to generate steam, to cool and heat, to fill varied needs of process and general plant services. These are areas with which report is concerned. Water that can be used without some treatment is rare indeed. Impurities must be removed, reduced or stabilized. Article discusses how treatment chemicals and application equipment solve everyday water problems.

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Publications Abstracted for GAS ABSTRACTS

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Air Pollution Control Association, Journal of
American Chemical Society, Journal of
American Gas Association Monthly
American Gas Journal
American Institute of Chemical Engineers, Journal of
American Petroleum Institute Quarterly
American Society for Testing Materials Bulletin
Analytical Chemistry
Appliance Manufacturer
Applied Chemistry, Journal of
Applied Mechanics, Journal of
Applied Mechanics Review
Applied Physics, Journal of
Applied Spectroscopy
ARS Journal
ASHRAE J.
Australian Journal of Applied Science
Australian Journal of Chemistry

Basic Engineering, Journal of
Battelle Technical Review
Bituminous Coal Research
Brennstoff-Chemie (German)
British Coal Utilization Research Association Monthly Bulletin and Quarterly Gazette
Business Week
Butane-Propane News

California Oil World
Canadian Chemical Processing
Canadian Gas Journal
Canadian Journal of Chemical Engineering
Canadian Journal of Chemistry
Canadian Journal of Physics
Ceramics (British)
Chemical and Engineering Data, Journal of
Chemical Society, Proceedings (British)
Chemical and Engineering News
Chemical & Process Engineering
Chemical Education, Journal of
Chemical Engineering
Chemical Engineering Progress
Chemical Physics, Journal of
Chemical Processing
Chemical Reviews
Chemical Society, Journal of (British)
Chemical Society, Proceedings (British)
Chemical Week
Chemistry & Industry (British)
Coal-Heat
Coal Utilization
Coke and Gas (British)
College Placement, Journal of
Combustion
Combustion and Flame (British)
Compressed Air
Computers and Automation
Construction Methods and Equipment
Control Engineering
Corrosion
Corrosion Technology (British)
Cost Engineering

Design News
Drilling

Electronics
Engineering for Industry, Journal of
Engineering for Power, Journal of
Engineers' Digest (British)
Erdöl und Kohle

Faraday Society, Transactions of (British)
Fuel (British)
Fuel Efficiency (British)
Fueloil & Oil Heat

Gas
Gas Age
Gas & Oil Power (British)
Gas Council Research Communications (British)
Gas Heat and Comfort Cooling
Gas Industries
Gas Journal (British)
Gas Times (British)
Gas- und Wasserfach (German)
Gas World (British)
Gasovaya Promyshlennost (Russian)

Heating, Piping & Air Conditioning

Independent Petroleum Association of America Monthly
Industrial and Engineering Chemistry
Industrial Finishing (British)
Industrial Gas (American)
Industrial Gas (British)
Industrial Heating
Industrial Laboratories
Industrial Research
Institute of Fuel, Journal of (British)
Institute of Gas Technology Research Bulletins
Institute of Petroleum, Journal of (British)
Institution of Gas Engineers Bulletins and Communications (British)
Instrumentation
Instruments and Control Systems
Izvestiya Akademii Nauk S. S. S. R. Otdelenie Khimicheskikh Nauk (Russian)
Khimiya i Tekhnologiya Topliva i Masel (Russian)

LP-Gas
Lubrication
Lubrication Engineer

Mathematical Tables and Other Aids to Computation
Mechanical Engineering

National and Space Administration Memorandum
National Fire Protection Association Quarterly
National Gas Bulletin of Australia
National Petroleum News
Nuclear Science and Engineering
Nucleonics

Oil and Gas Journal
Optical Society of America, Journal of
Organic Chemistry, Journal of

Petroleum (British)
Petroleum Engineering
Petroleum Refiner
Petroleum Technology Journal of
Petroleum Week
Physical Chemistry, Journal of
Physics and Chemistry of Solids (British)
Physics of Fluids (British)
Pipe Line Industry
Pipeline News
Power
Producers Monthly
Product Engineering
Progress (Pakistan)
Public Utilities Fortnightly

Research, Journal of
Research & Engineering; the Magazine of Datamation
Review of Scientific Instruments
Revue Generale du Gaz (Belgian)
Rivista dei Combustibili (Italian)

Science
Scientific Instruments, Journal of (British)
Svenska Gasverksföreningens Månadsblad (Swedish)

Technical News Bulletin

U.S. Bureau of Mines Bulletins, Information Circulars and Reports of Investigations
U.S. Patents
Usines a Gaz, Journal des (French)
Uspekhi Khemii (Russian)

World Oil
World Petroleum